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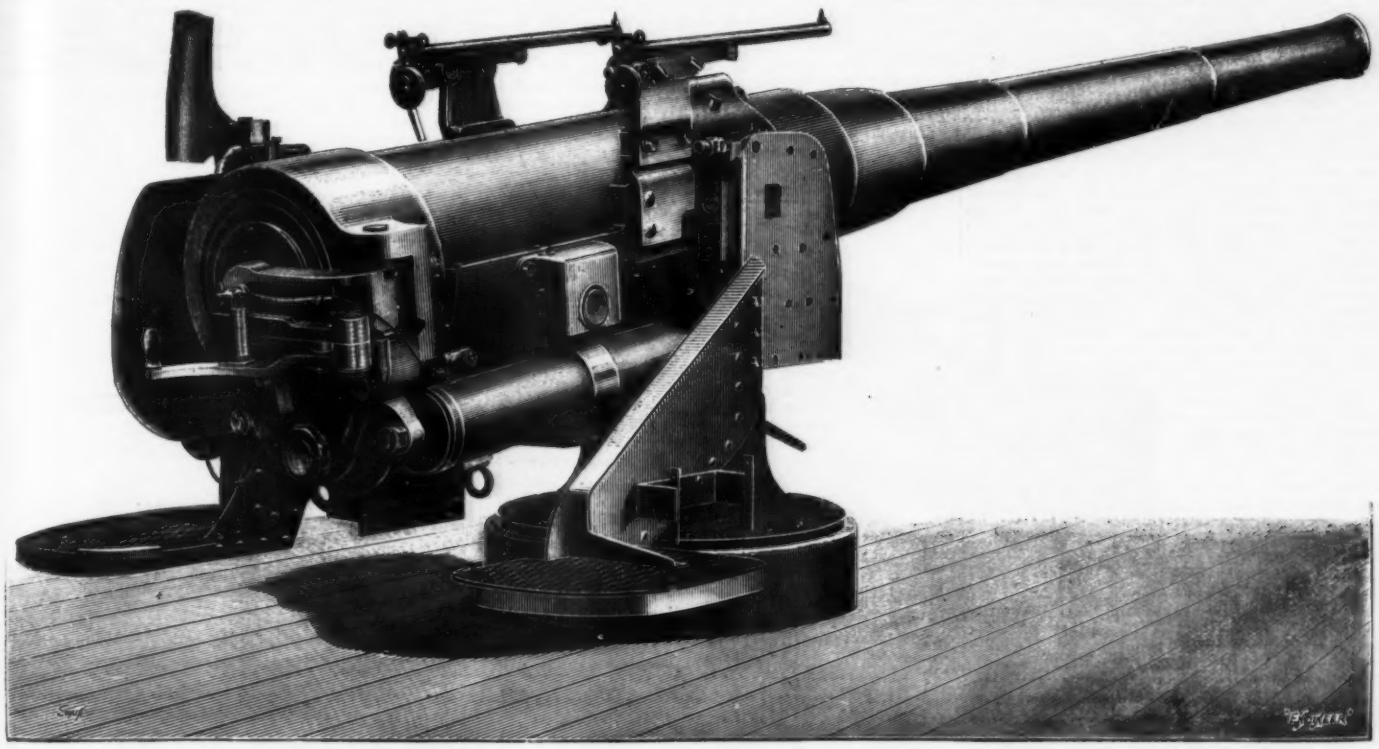
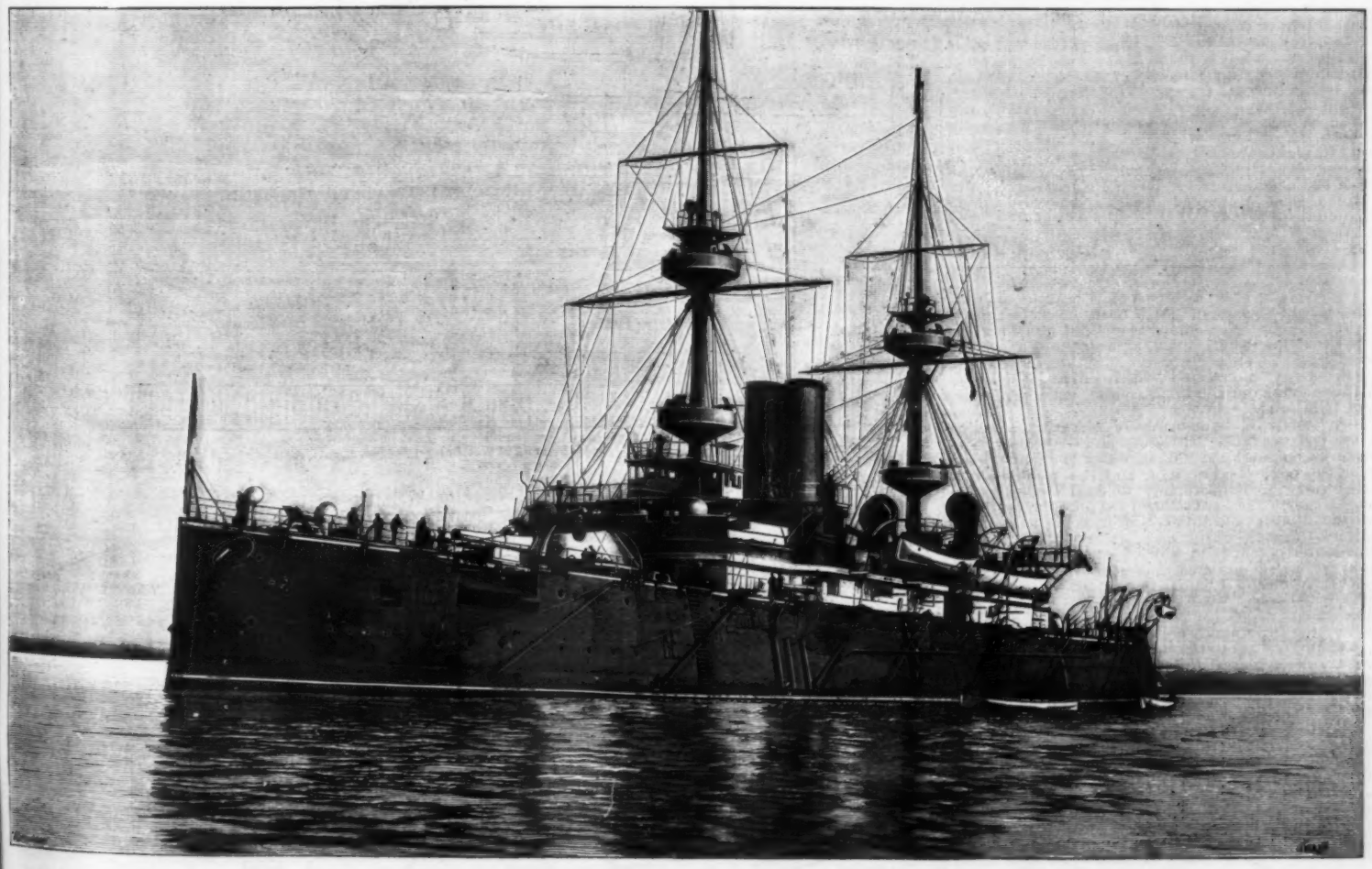


SIX INCH RAPID-FIRE WIRE-WOUND GUN OF THE PRINCE GEORGE ON UPPER DECK MOUNTING.

Weight of projectile, 100 pounds; velocity, 2,500 feet per second; rounds per minute, 7.



FIRST-CLASS BATTLESHIP PRINCE GEORGE.

Length, 390 feet; beam, 75 feet; displacement, 14,900 tons; speed, 18·3 knots. Armament: four 12 inch wire-wound guns; twelve 6 inch and twelve 3 inch R. F. guns; twelve 3 pounders.

THE BRITISH FIRST-CLASS BATTLESHIP PRINCE GEORGE.

WHEN the English government passed the Naval Defense Act, under which some seventy ships were added to the navy, the most striking feature of the programme of construction was the provision for building nine battleships of the then unprecedented size of 14,150 tons. These ships were commissioned in due course, and are now known as the Royal Sovereign class. The next battleships to be authorized were slightly larger in size but generally similar in design. As before, nine ships, identical in size, speed, and power, were ordered, and the class is known as the "Majestics," after the first ship to be put in commission. The Prince George, which forms the subject of our illustrations, is one of the latter class.

In considering the designs of battleships adopted by the various navies of the world, it must be borne in mind that they are largely determined by the class of work which the ships will have to perform. It has always been the policy of England to carry on her naval wars as far from her own coasts and as near to those of the enemy as possible. Moreover, her possessions are widely scattered, and her ships must be prepared to cross the seas and fight, it may be thousands of miles from her shores. Hence it is imperative that her battleships shall be thoroughly seaworthy, and capable of keeping the sea for a long period of time without returning to port. This necessitates high freeboard and large coal carrying capacity, which, taken together with the high speed, which in the Prince George reached 18$\frac{9}{10}$ knots on a continuous four hours' trial, necessitates a large ship. Hence the great displacement of the Majestic class, which, with all stores on board, will be something over 15,000 tons.

In a recent special number the London Engineer has given an elaborate description of the Prince George, from which we have selected our illustrations, and much of the descriptive matter that follows.

The Prince George is 390 ft. long between perpendiculars, and 425 ft. long from her stern galley to the point of her ram bow. The extreme breadth of the Prince George at the waterline is 75 ft., but her sides tumble back "home" rapidly from this point, hence the plans of her main deck and upper deck do not give the full beam; but this is seen in the compound cross section. The mean draught of water is 27 ft. 6 in., being about one foot greater aft than forward. The cross section amidships is, as observed in the half section, tolerably full in the bilge, and this point appears more prominently still in a full cross section, squareness of bilge being quite a leading feature of the new ships. Already the modification appears to have worked wonders in the behavior of these great battleships in a seaway. The Majestic and Magnificent are said to present a remarkably steady gun platform.

The ship has a considerable sheer forward, the extreme freeboard at the stem being 25 ft. 3 in., while amidships and aft it is about 20 ft. This gives great headroom under the forecastle, the space between decks being fully 12 ft., and admitting of the construction of a lofty sick bay, to which we shall presently advert. In order to assimilate with the sheer forward, the barbette, or redoubt, as it is officially termed, is made 4 ft. higher than that aft, the armored walls of it being correspondingly deeper in their descent to the level of the armored deck. The Prince George has six decks—boat or shelter deck, upper deck, main deck, middle deck, lower deck, and platform deck. The boat deck is 54 ft. above the keel. But the highest bridge of all, that upon the chartroom forward, is 75 ft. above this level, hence the lookout which is obtained from this station is necessarily most extensive. An important modification in this class, as apart from that of the Royal Sovereign, is the boat or shelter deck, covering the corner casemates for 6 in. guns, on the upper deck, and the 12 pounders on the beam. The central portion is uncovered, but it is to have a netting stretched across it, on service, which will catch splinters and fragments from the boats, masts, gear, and spars above, if injured.

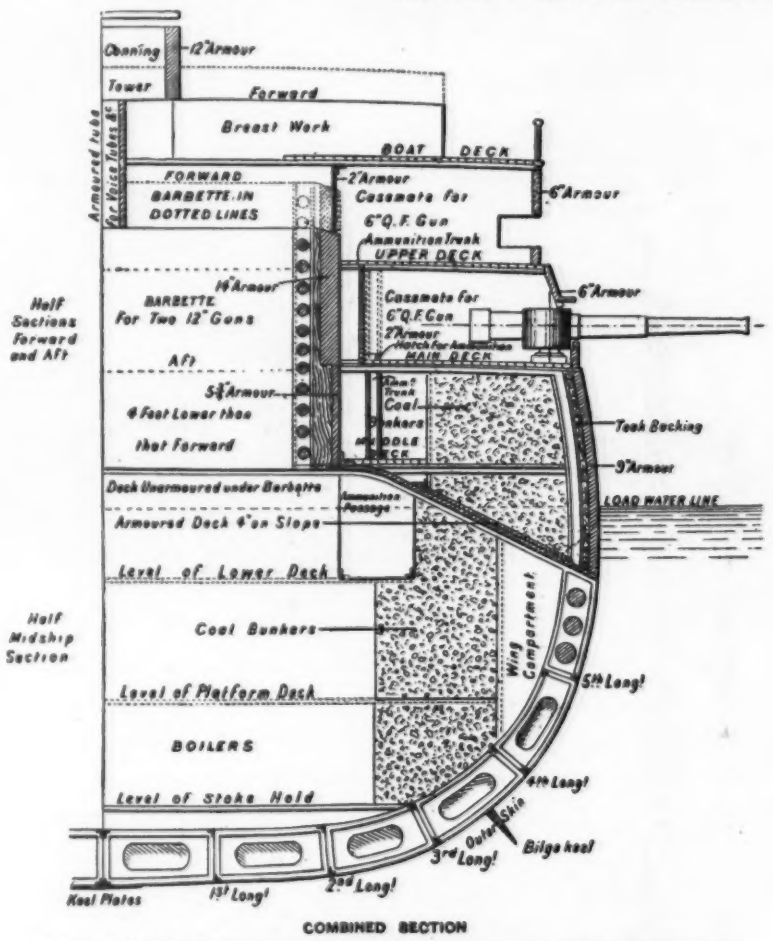
The protective arrangements of this ship combine the best features of the battleship and the cruiser. The hull consists of an inner and an outer shell up to the level of the vertical side armor, and the whole ship is divided into 318 compartments, to each one of which special arrangements are applied for pumping or flooding. One hundred and fifty-five of these compartments are below the armored deck, exclusive of 72 which are in the double bottom and wings, sections of which are seen in our engraving, and 91 are above the armored deck. Two hundred and twenty-three watertight doors are associated with the most important of the compartments which are accessible, some of which are closed by butterfly hand screws, others by screw gearing, with pinions led to the upper or main decks, where there are deck plates and keys for actuating them. Over the vitals the armor protection consists of a 3 in. armored deck, flat over the engines and boilers and sloping at the sides, where it is 4 in. in thickness, until it reaches the edges of the lower deck. With this is associated a wall of side armor 9 in. in thickness and 15 ft. in depth. The 4 in. sloping portion of the deck, taken diagonally, equal to 5 in., added to the vertical 9 in., constitute roughly, with the 14 in. bulkheads, a citadel 252 ft. long, 75 ft. wide, and 7 ft. 6 in. in depth round the vitals, completely covered with 14 in. armor.

At either extremity of the arched portion of the armored deck is built an armored redoubt for two 12 in. breechloading wire guns. The armored portion of the redoubts, which is within the upper strake of 9 in. vertical side armor, is only 5 in. thick, as the two, taken together, make up the total of 14 in. required; above and beyond this influence the redoubt walls are 14 in. solid to the place where they emerge upon the upper deck. An armored hood, which revolves with the turntable, protects the guns upon the summit of the redoubt; this is 9 in. thick in front and thins out toward the rear.

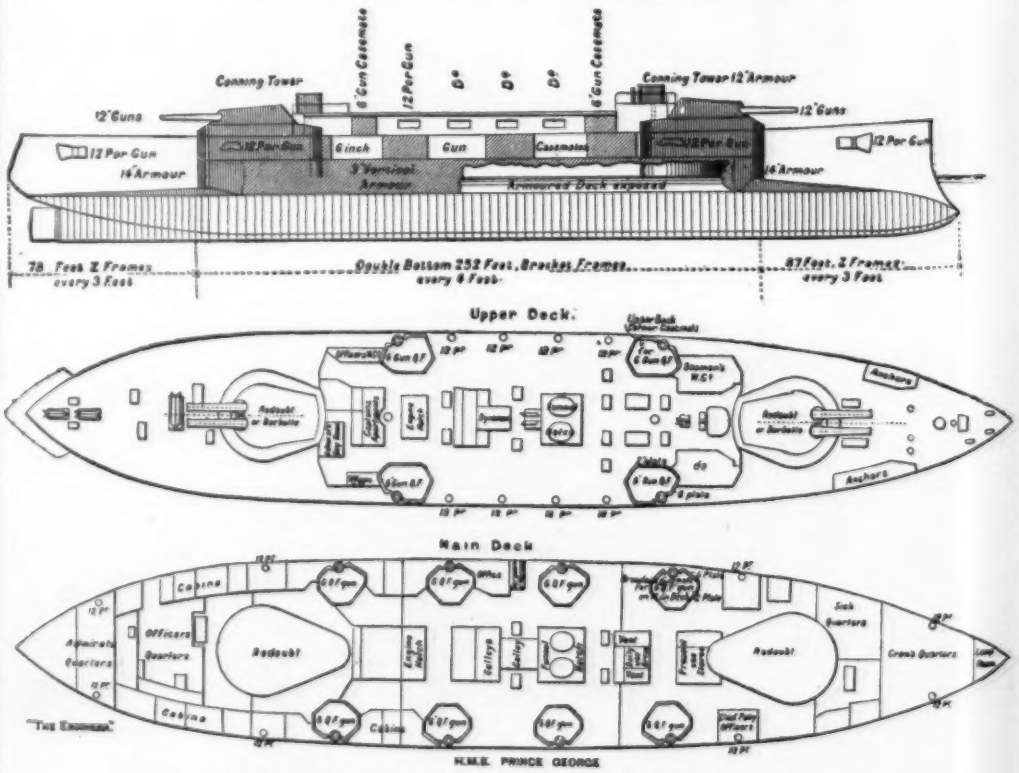
Beyond the arched part of the armored deck and running forward and aft are two supplementary portions of it, 2½ in. thick, extending to the cast steel stem and dovetailed into it; also to such a distance aft beyond the stern post and rudder head as to protect the steering engines.

The casemates for the 6 in. quick-firing guns are protected by 6 in. armored shields on the outside, as will be seen from the engraving of the cross section, and by 2 in. walls on the inside. The forward conning tower has 12 in. armor plates upon it, but the after conning tower is only 6 in. thick. Armored trunks are employed everywhere, leading from beneath the armored deck to the fighting positions for the 6 in. guns. The weight of the armored deck and the vertical armor amounts to 3,500 tons. The position of the coal bunkers on board the Prince George has been most judiciously selected, with a view to afford, as far as possible, a considerable

SIX INCH WIRE-WOUND GUN OF THE PRINCE GEORGE, SHOWING DISPOSITION OF WIRE.



HALF CROSS SECTIONS OF THE PRINCE GEORGE, SHOWING DISTRIBUTION OF ARMOR AND COAL PROTECTION.



SIDE ELEVATION AND DECK PLANS OF THE PRINCE GEORGE.

extent of protection to the vitals of the ship, above and beyond that given by the vertical armor and the armored deck. A glance at the compound section shows that the middle deck has amidships and for a considerable distance fore and aft a solid mass of coal, in bunkers on either beam, nearly 12 ft. thick.

The whole of the armor consists of steel plates having the outer surface carburized by the Harvey process, which greatly increases the resistance of the plates to penetration.

The main armament of the Prince George consists of four 12 in. breech-loading guns, fitted in pairs in the two pear-shaped redoubts just described, one at each end of the ship, and mounted on revolving turntables, the whole being worked either by hydraulic power or by hand power, supplemented by the assistance of electromotors.

The 12 in. gun, two of which are situated in each barbette of H. M. S. Prince George, is 40 calibers in length, its full length being 445¼ in., or 37 ft. 1¼ in., and it weighs 46 tons. The entire gun from muzzle to breech is wound with wire, and the outer course over the wire is composed of two tubes only, that over the chase portion being considerably longer than half the length of the gun. A short screwed hoop makes the connection between these two where their ends abut. A notable feature is the double barrel consisting of two concentric tubes, the inner one fitting exactly throughout its entire length into the outer one. This arrangement has been designed with a view to facilitating and cheapening the relining of the gun, as the entire inner tube or a portion of it may be withdrawn at any time and replaced at comparatively slight expense, making the gun practically as good as new. The wire or ribbon used on these and on the 6 in. gun is ¼ in. wide by 0·06 thick, and its ultimate strength per square inch of cross section lies between 90 and 110 tons. It is wound on in a number of separate sets of layers, the tension varying between about 30 tons to 60 tons per square inch, according to the position of the layers. The actual weight of wire on each 12 in. gun is approximately 12 tons, corresponding to a length of nearly 100 miles. The projectile fired weighs 850 lb., and the bursting shell is over 5 ft. long. With the full charge of 167½ lb. of cordite, a muzzle velocity of 2,400 foot seconds is obtained, the muzzle energy reaching 738 foot tons per ton of gun —a figure far exceeding anything before obtained with large ordnance, corresponding to a perforation of wrought iron by Krupp's formula of nearly 31¼ in. at 2,000 yards. These guns can be fired from the fixed loading position at the rate of four rounds in five minutes, which is nearly double that of the guns of the Royal Sovereign class.

There are also twelve 6 in. quick-firing guns, all mounted in armored casemates, eight being on the main deck and four upon the upper deck. Sixteen 12 pounder quick-firing guns are mounted upon the main and upper decks, the latter being behind the vertical walls beneath the boat deck, and between the corner casemates of the upper deck, so that their positions are sheltered from raking fire by the casemates. The armament is completed by twelve 3 pounder Hotchkiss guns in the fighting tops on the masts, two 12 pounder 8 cwt. quick-firing boat and field guns, and eight 0·45 in. Maxim guns, mounted in various positions upon the superstructure. Twenty-two torpedoes will be carried, which can be fired from four submerged tubes, two forward and two aft, and from one above-water tube at the stern.

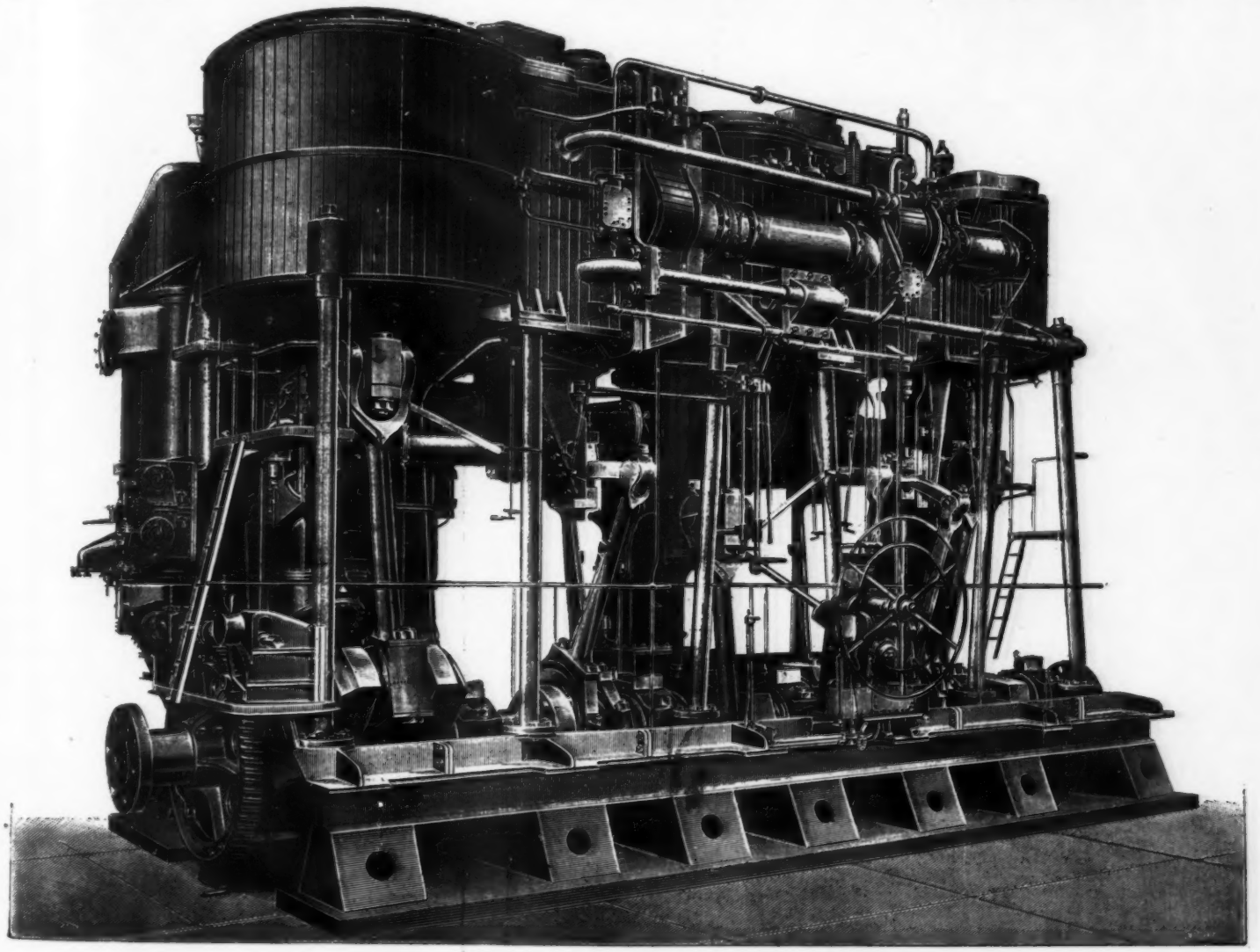
The six inch guns, of which we give a part sectional view and an elevation, were manufactured at the Elswick works. They are of wire construction. They are 40 calibers long, the total length from breech face to muzzle being 249¼ in. Broadly speaking, each gun consists of a long tube technically known as the A tube, or barrel bored out to exactly 6 in. diameter for the greater part of its length, the chamber section being tapered to allow of the free removal of the brass cartridge case. On to the rear portion of this tube is contracted a second tube, and round this is tightly bound the steel wire or ribbon, the tension varying in successive layers, according to the principles formulated by Mr. Longridge. Over the wire is lightly contracted a jacket, on which are cut the steel keys designed to prevent any rotation of the gun by the inertia of the shell in the rifling, and to cause the gun to recoil in a straight line. Finally, over the muzzle half of the A tube a chase hoop is shrunk on, and over the rear end of the jacket is screwed and contracted the breech ring, from the lower side of which projects a stout arm to which the piston rod of the recoil cylinder is secured. The breech mechanism of these and the 12 pounder guns is of the usual Elswick quick-fire pattern. The breech screw is made on the interrupted screw principle, a part of a turn being sufficient to unlock it. But it differs from the screws of other makers in having its front half steeply tapered, the interruptions on this part coming opposite the full thread on the parallel part; the pressure is thus very much more evenly distributed round the gun than in the case of a parallel screw. The taper is at the same time necessary to allow the action of the breech mechanism, as will be seen presently. This mechanism consists of a strong bronze carrier, hinged to the right side of the breech ring. It supports, on a large spigot formed on its face, the breech screw. Rotating round the carrier hinge pin as a fulcrum is a long curved lever, which passes right across the breech of the gun when closed, and terminates in a handle. Attached at a point along this lever is a link, the other end of which is hinged to a block sliding in a guide cut in the carrier. Into this block fits a pin, secured at right angles to the rear face of the breech screw, and at some distance from its center. Suppose now that the breech is closed ready for firing, the long lever and the link lie close against the breech screw, the sliding block being pushed to the limit of its stroke in the guide in the carrier. To open the breech the lever is pulled steadily backward from the gun, just as if the breech were closed by a simple valve or door. This action puts a tension on the link, which in consequence draws the slide block toward the carrier hinge, and this movement must evidently cause the breech screw to receive a partial rotation through the medium of the pin in its face fitting into the block. The continuation of this movement of the hand lever after the unlocking action is complete causes the whole carrier to swing on its hinge, bringing the breech screw out with it.

The main engines, which are each of 6,000 horse power, are of the vertical twin screw, triple expansion type. The high pressure cylinder is 40 in. in diameter, the intermediate 59 in., and the low pressure 88 in., the stroke being 4 ft. 3 in. Each crank shaft is of hollow steel, in three parts, of 15¾ in. diameter at the bearings, the crank pin being of 16¼ in. diameter and 18 in. long.

The two main condensers have a total cooling surface of 13,500 sq. ft., and the two auxiliary condensers a total surface of 1,800 sq. ft. The main air pumps, of which there is one to each engine, are 18 in. in diameter. There are four centrifugal pumps for supplying circulating water to the main condensers, with impellers 3 ft. 10 in. in diameter. These centrifugal pumps are capable of throwing 1,200 tons of water each, or 4,800 tons for all four, in a single hour; hence their value for clearing the ship of large bodies of water, in an emergency, would be enormous, although, as before explained, either steam or hand pumps are employed except on extraordinary occasions.

There are eight single-ended cylindrical boilers, with return tubes, having a total heating surface of 24,400 sq. ft. and a total grate surface of 820 sq. ft. The amount of coal usually carried is 900 tons, but bunker provision is made for storing 2,250 tons. If coaled up, therefore, to her full capacity, the Prince George could steam for nearly nineteen days at about 15 knots speed without replenishing.

On her four hour, full power trial trip, the average speed was 18·3 knots per hour, the engines indicating 12,253 horse power. The ship has been commissioned with a complement of 738 officers and men, though there is actual accommodation for 850 if necessary.



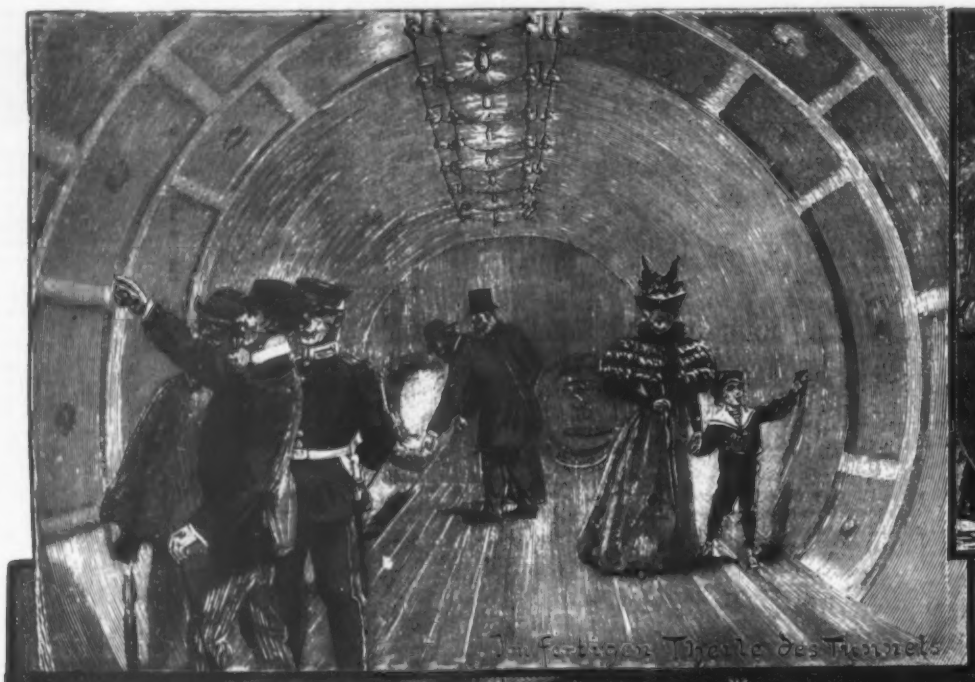
TRIPLE EXPANSION ENGINES OF THE PRINCE GEORGE.

Combined horse power of the twin engines, 12,253.

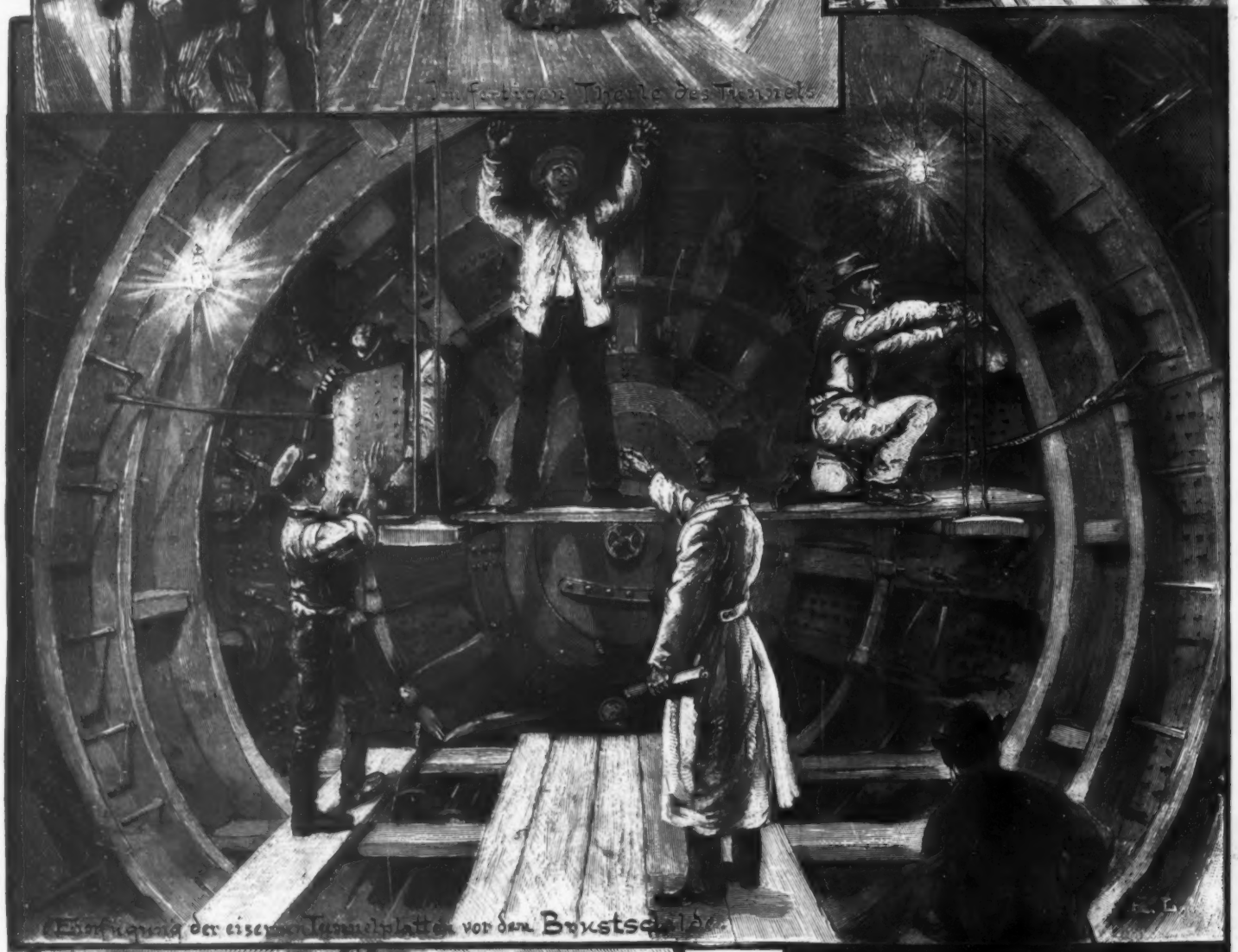
TRAFFIC ON ASPHALT.

TRAFFIC on asphalt paved streets in Milwaukee has recently been investigated at the instance of a corporation which requested the city authorities to take a count of the traffic on the principal streets, says the Engineering News. This covered seven days in September and the period between 6 A. M. and 7 P. M. Four of the seven days were cloudy; in two of them there was slight rain, and in one a continuous rain. The greatest number of vehicles passing in any day of thirteen hours was 5,146, and the smallest was 1,328, on Sunday. The daily average was 4,090·61. The greatest number of horses was 6,930, and the least 1,700; the daily average of horses being 5,433·40. Electric street cars were not counted as traffic, as they were supported by the rails; but the daily average of such cars was

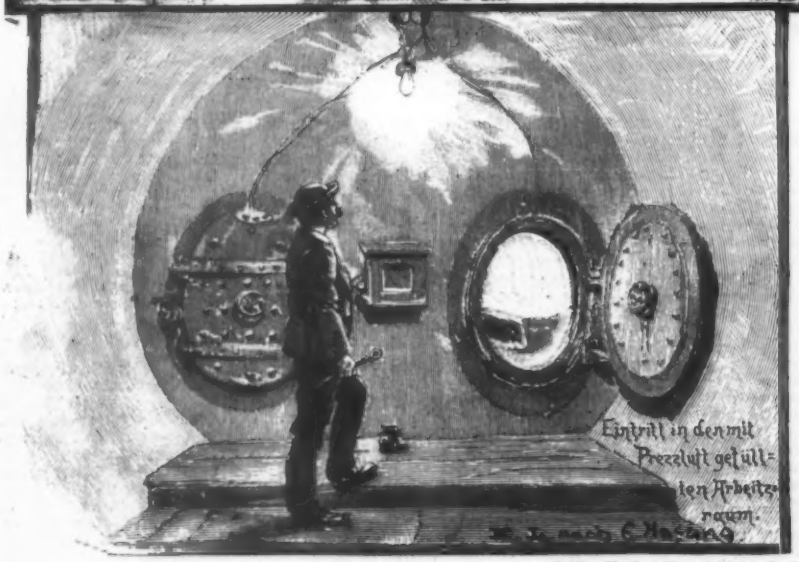
The Completed Section of the Tunnel.



Working Chamber of Shield.

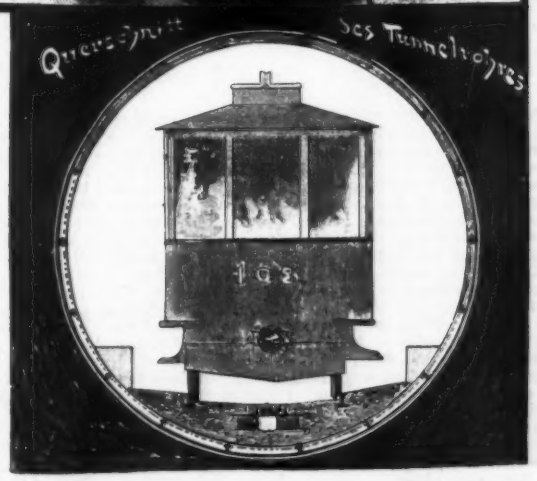


Air Locks Leading to Working Chamber.



Setting Up Iron Tunnel Lining Back of Shield.

Section of Tunnel.



THE CONSTRUCTION OF THE TUNNEL UNDER THE SPREE, NEAR TREPTOW.

1,902 for the thirteen hours selected. The speed record showed that 48 per cent. of the horses were walking and 52 per cent. trotting. Of the weights moving, 38 per cent. were moving at a walk and 62 per cent. at a more rapid rate. The proportion of vehicles weighing less than one ton, with their load and outfits, was 29·7 per cent. of the whole; of heavier loads, 24·83 per cent., and of horses 45·47 per cent. The pavements showed the effect of three years' use. The average daily number, class and weight of horses, vehicles and loads is shown in the following summary of the schedules:

	Horses.	Vehicles.	Tons.
Loads under one ton:			
Walking	1,633	1,243	1,438
Trotting	2,719	2,304	2,512
Loads from one to three tons:			
Walking	543	281	834
Trotting	119	61	182
Loads from three to five tons:			
Walking	393	196	982
Trotting	5	3	13
Loads over five tons:			
Walking	3	1	5
Horses not attached:			
Walking	17	....	8
Speeding	1	....	½
Electric cars	...	1,902	....
Total daily ave'ge.	5,433	4,091	5,974½

The average weight of daily traffic to each foot in width of roadway, not including weight of street railway cars, was 119,486 tons.

THE TUNNEL UNDER THE SPREE, NEAR TREPTOW.

A QUARTER of a century ago one was met with an incredulous smile if he affirmed that Berlin would become one of the greatest cities of the world; it has now attained that distinction, however, and the best proof of this lies in the fact that although about 50,000 houses stand empty, building is continued quietly and street traffic grows in proportion as the population increases. In Unter den Linden, Leipzigerstrasse, at the Halle Gate and on the Potsdamer Platz a flood of men and vehicles is frequently dammed up. Many propositions have been made for relieving the congested condition of these thoroughfares, but none of them seemed to meet all the requirements, which seem to demand either an elevated or an underground road. The first real trial of the former, as the Langen enterprise was not carried out, is being made now by Siemens & Halske, between the Silesian Station and the Zoological Garden—a line which seems to form a reasonable extension of the city railroad. Another section of elevated road has been planned for opening up the north and south, but very little is heard of underground roads. It is claimed that the conditions of the ground water and the sandy nature of the ground under Berlin are unfavorable to tunneling within the city limits and proof is demanded that such an undertaking would not be injurious to the residence quarter under which the tunnel would be carried before consent will be given for the construction of an underground road. In London, the conditions are entirely different, for there the tunnel is above ground water and is bored through limestone, which is easily worked but firm enough to prevent any settling of the surface of the ground.

To obtain a practical solution of this problem, so important to Berlin, a special company was formed some years ago, which, as it was impossible to obtain permission to tunnel under the city, began a tunnel under the Spree, between Treptow and Stralau, that was completed to the middle of the river. This scheme naturally excited the greatest interest, and the city of Berlin required frequent reports of the progress of the work. It was necessary to settle the important question whether the boring would affect neighboring buildings, and some structures were erected near the bank of the river for that purpose.

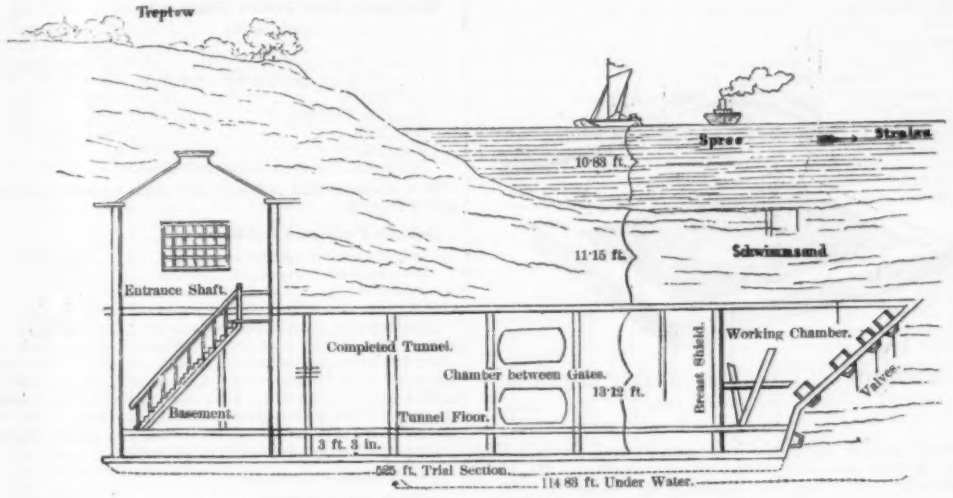
Work on the tunnel proper, which occupied the whole summer, required considerable preparation. First of all, the arrangement of the shaft, the making of the working shield, and the setting up of the machines for purposes of electric lighting and compressing water and air. In determining the proportions of the tunnel, the chief object was always kept in view; that is, that it should form a part of a future street railroad from Treptow to the Silesian Station. To this end a circular section 13 feet in diameter was decided upon, that being large enough to allow a street car to pass through, a walk was provided at one side for the men and the drain arranged under the track.

The lining of the 1,476 foot section of the tunnel was constructed of iron and set up of annular sections each 2 feet 1 inch deep, with flange joints. These annular sections were set up as the shield advanced. The shield, which has been patented by the German engineers, Mackensen and Lauter, is pressed forward by sixteen hydraulic rams, which are spaced evenly around the circumference, and which, by unequal pressure, can impart a curved movement to the body of the shield, so constructed that it can turn on ball bearings. The shield is provided with a cutting edge for loosening the earth, and is provided with openings through which this ground can be sounded with the help of a sounding iron. The loose earth is drawn in through lock valves and then carried from the working compartment to the surface of the ground by hand carts or water pressure.

As the tunnel is only about 10 feet below the bottom of the Spree, the bottom of the tunnel being about 33 feet below the mean water line of the river, the difficult boring under the level of the ground water is done under air pressure, the men working in a chamber under one atmosphere excess of pressure.

These conditions necessitated the building of the tunnel in sections, which are connected by two gates for equalization of the air pressure. In passing down from the outer air through the low canal, the compressed air, which is admitted through a valve, produces such a pressure on the tympanum of the visitor as to affect the hearing, and in passing from the compartment in which the men are working one experiences a sensation similar to that caused, when in a bath, by a sudden rushing of warm water into the ear. The air pressure causes a pricking sensation in the ears when one is not accustomed to these conditions, but healthy people experience no other inconveniences of any importance. A third of the tunnel has been constructed, and, thanks to the good management of Mr. Schnebel, no accidents have occurred.

In September the work of construction was begun so as to bring the negotiations for the underground railroad between Stralau and Humboldthain, which the same company was trying for, to a definite conclusion. In this way many thousands of visitors to the Trade Exposition were given an opportunity of seeing the section of the tunnel already completed, about 390 feet, which was perfectly dry and lighted throughout its length by electricity. Telephone wires were carried along the roof of the tunnel, so that those at work could communicate with the outer world. Many people passed through to the chamber where the men were at work, but the advance of the shield, often 6 feet 6 inches per day, continued all this time without difficulty. Yet the inrush of quicksand caused depressions in the surface of the ground, proving that this system is not adapted for use under ground that has been built upon, and therefore for the rest of the tunnel a new, wedge-shaped shield will be used which, it is hoped, will meet all requirements for tunneling under the city of Berlin.—Illustrirte Zeitung.



LONGITUDINAL SECTION OF THE SPREE TUNNEL.

THE WATER POWER OF THE DRAINAGE AND SHIP CANAL, AND ITS TRANSMISSION TO CHICAGO.*

By H. S. PUTNAM.

INCIDENT to the sanitary benefits of the drainage canal, and especially to its use as a ship canal, a magnificent water power is made available which can be developed and utilized at a comparatively small expense. With the drainage canal you are all more or less familiar, and its description here is not necessary. Its utilization as a ship canal has also been frequently agitated, and has been an important factor in its plans and construction. It may be some years before these plans are fully carried out, as the scheme is gigantic in its proportions and will require time and money to complete. However, upon the completion of the drainage canal a large portion of the expense of opening a deep water route from Lake Michigan to the Gulf will be covered. When we consider the vast importance of such a route to the whole Mississippi Valley, and ultimately, in connection with the proposed deep water ways to the eastward, to the whole country, in the matter of transportation facilities and freight rates, it is more than probable that the balance necessary to complete such a route to the Gulf will be forthcoming in the very near future.

The drainage canal, when completed, according to the present plans and contracts, will stop at Lockport and will have a flow of 300,000 cu. ft. of water per minute. After deducting say 6 ft. for the slope on the surface of the canal, there will be available at Lockport about a 12 ft. head of water. With a turbine of 85 per cent. efficiency, this will give us 5,800 available horse power. Upon the completion of the canal, however, as a ship canal, with the flow at the full capacity—600,000 cu. ft. per minute—a water power will be developed of immense value to the community and also to this city. Lake Joliet, just below the city of Joliet, is 76 ft. below the low water mark of Lake Michigan. Allowing 6 ft. as before for the slope in the surface of the canal, we will be able to utilize the remaining 70 ft. in two steps, one at Lockport and the other at Joliet, of nearly equal amounts. As the tail races of the power used at Lockport can be turned back into the canal, no water will be lost, but it all can be utilized for the entire fall. Taking the efficiency of the turbine wheels as before at 85 per cent., and allowing a loss of 1 ft. of the head in the rise of the water in the tail races and other obstructions to its flow, at each step, we have available 65,700 actual horse power, in two steps of nearly equal amounts at Lockport and Joliet.

I will endeavor first to show the feasibility of the project from an engineering standpoint, and second, the financial phases of the question. We will first consider the power plant.

In building the retaining walls and locks for the ship canal at Lockport and also Joliet, the flumes and openings in the wall for the water power can be left at practically no additional expense, and what little there may be, the authorities will certainly feel justified in creating, in consideration of the financial returns that they can obtain from a rental of the power. Therefore we have only to consider our discharging tail race or shunt around the ship locks, as far as the handling of the water is concerned. Such a tail race would necessitate the removal of less than 25,000 cubic yards of material, mostly rock. At Lockport this tail race would have to be constructed, but at Joliet it is very probable that the water could be discharged directly into the river at a very small expense. At the prices now prevailing in the country for this class of work, from 20 per cent. to 25 per cent. lower than the prices current at the time the contracts for the drainage canal were let, owing largely to improved machinery, this excavation for both plants would cost less than $25,000. Adding $25,000 more for the necessary retaining walls would make this part of the plant cost approximately $50,000.

The turbine wheels can be very easily made in pairs, each pair connected directly to the electrical generator or whatever machinery it may be required to drive. With the head under consideration, these pairs can be made of 3,000 horse power each, 20 such wheels, say 10 in each station, being required for the entire plant. Ordinary turbine wheels can be bought for $1 per horse power. Especially designed wheels, with necessary flumes, gates, regulators and erected in position, for about $5 a horse power. To cover especial features, however, and also the two station houses, which would not be expensive, I have estimated the cost of the entire power plant, with the turbines ready to run, at $500,000, or $10 per horse power. This figure can certainly be very considerably reduced.

Next we must consider the method of utilizing this power, but more especially, in the present instance, its transmission to Chicago, a distance of 40 miles. By the use of electricity about 80 per cent. of the power developed by the turbines can be delivered to the consumers in Chicago. Certainly a better showing than is made by the compressed air plants now in operation.

Adopting electricity, therefore, as the means of transmitting this power, the alternating current is selected on account of its flexibility, ease of conversion and the high voltage it enables us to use in its transmission, thus effecting an immense saving in copper. A low number of alternations per second, not exceeding 30, is selected, so as to avoid the induction losses which would be excessive at a higher frequency. The use of this low frequency may interfere somewhat with the use of arc lights on the circuit directly, but by the use of proper rotary transformers this can be rectified. For all other purposes there is no objection to this frequency.

As it is not advisable to build generators of too high a voltage, the generators in question should have a voltage of about 2,000 volts, and in order to be directly connected to the turbines, of 3,000 horse power or 2,250 kilowatts capacity each. It would be preferable to make these as large as possible, and a careful consideration of the turbine wheels to be used might enable their size to be increased. The polyphase current would be adopted as offering numerous advantages over the single phase, especially in the use of motors, and the three phase instead of the two phase current on account of the great saving in copper in the transmission line, a very important consideration when the energy must be conveyed 40 miles. Step-up transformers, changing the voltage from 2,000 to 20,000 volts, should be used, as it would be impracticable to transmit this energy 40 miles at a low voltage on account of the immense amount of copper necessary. It requires 3,000 tons of copper at 20,000 volts. If we used 2,000 volts instead, one hundred times this amount would be required for this line, with the same percentage of loss. For the purpose of avoiding the inductive and condenser losses on the line, an overhead pole line is very much preferred, and this can be constructed very nicely along the banks of the canal. Owing to the inductive effects of large wires, comparatively small wires are desirable, and, consequently, the circuits must be subdivided. In this case No. 0 wire has been selected. It will require 30 circuits of three wires each of No. 0 wire to transmit the energy in question with a 10 per cent. loss. This will require 3,600 miles of No. 0 wire, weighing over 6,000,000 pounds. As illustrating the importance of the size of the wire with inductive currents, if 0000 wire were used, it would require one-third more copper. The line has been computed on the basis of a 10 per cent. loss of energy, as probably the most economical in the present instance. Mutual induction between the circuits can be avoided by criss-crossing the wires on the pole line so as to counteract any mutual effect between the adjacent circuits. Bare copper wire has been selected.

For the purposes of this paper, the distribution and

* Abstract of a paper read at a meeting of the Illinois Chapter of the American Institute of Architects.—From Electrical Industries.

utilization of this energy for power purposes in large units is all that is contemplated. For local distribution, especially for lights and small powers, a local company would undoubtedly be organized to carry out that part of the business, or power could be furnished to the companies at present engaged in electrical generation.

In the foregoing discussion, a 2 per cent. loss has been assumed in the step-up and also in the step-down transformers; a 10 per cent. loss in the line, and an efficiency of 95 per cent. in the electrical generators, and 85 per cent. in the turbine wheels. Apparatus is in use to-day showing fully as good results as have been assumed, and there is no reason why these figures cannot be equaled, if not improved upon, in the plant under consideration. These efficiencies have, of course, been assumed under the conditions of full load, but the efficiencies of the apparatus as manufactured to-day would be only slightly less at any probable underload, while the losses on the line would be decreased. At full load, according to the above figures, the consumers would be furnished with 82 per cent. of the power received from the water wheels, and it is not probable that the efficiency of transmission would fall below 75 per cent. under any ordinary conditions of under-load.

From the above it is readily seen that there are no serious difficulties in the way of transmitting this power to the city from an engineering standpoint. Financially, the project is even more attractive. The following estimate has been prepared from actual figures which have been submitted to the writer by manufacturers, but in all cases increased in size to cover unexpected contingencies, and also the extra cost of getting only the very best of everything, irrespective of cheaper apparatus that might be obtainable, but possibly of inferior grade.

ESTIMATED COST OF PLANT.

Water power plant, turbines and buildings complete	$500,000
Tail races and discharges	50,000
Electric plant, including generators, transformers, etc	1,250,000
Transmission line, 3,600 miles No. 0 wire, pole line, etc	1,000,000
Distribution, sub-stations in Chicago	50,000
Engineering and sundries	150,000
Total cost	$3,000,000

INCOME AND EXPENSES.

Rental of 50,000 horse power at $25 per year		$1,250,000
Interest on investment at 4 per cent	$120,000	
Depreciation at 4 per cent	120,000	
Repairs and supplies	10,000	
Labor and superintendence	40,000	290,000
Excess of income over expenses		$960,000
Deducting $5 per horse power rental to drainage district		250,000
Net income		$710,000

Or 27 per cent. on the investment.

As will be at once seen from the above estimate, it is very liberal. In all probability the cost of the plant can be kept below two and a half millions. The charge of 4 per cent. depreciation on such a plant is excessive, as much of it is subject to but little, if any, depreciation. The interest charge is hardly an operating expense, but it is put in on account of the prevalent custom to-day of bonding an enterprise to the full extent of the investment, thus making the interest a first lien on the income.

The charge of royalty or rental on the part of the drainage district is an uncertain quantity, so it has been estimated at $5 per horse power per year.

Suffice it to say in conclusion that we can scarcely overestimate the importance of the drainage and ship canal as a source of power to the city of Chicago, and that both from an engineering standpoint and financially it offers a very attractive field for our attention.

HOME-MADE GRADUATED MEASURES.

GRADUATIONS on glass bottles, measures, etc., may be easily engraved with the aid of a few small files, a set of six of which, of various shapes, can be bought at most tool shops for about one shilling. A small bottle of oil of turpentine in which some camphor has been dissolved is also very useful as a lubricant, although it is not absolutely necessary.

Suppose it is wished to graduate a bottle which will hold about ten ounces or half a pint of water. First fix a strip of gummed paper, about three-quarters of an inch wide, vertically on the outside of the glass, taking care that it is long enough to come slightly above the place where the ten ounce mark will be. When the gum is dry and the paper slip firmly secured to the glass, pour exactly ten ounces of water in the bottle, place the latter on a flat table, and when the surface of the water has become level and perfectly steady, mark the height in pencil on the paper strip. Now take a dry graduated two ounce measure, pour two ounces of water from the bottle, and mark the level of the eight ounces remaining; in the same way register the position of the six, four, and two ounce marks. Then empty the bottle and proceed to refill it, one ounce at a time, marking the level of the water at each addition; every second ounce to agree with the marks made at first, and in this way the correctness of the measurements will be checked.

When satisfied with the accuracy of the graduations, file with one edge of a fine triangular file through the paper where each mark occurs, until you feel that the tool is cutting into the glass. The marks can be made any length you please; the file cannot slip, as the paper will keep it in the proper place. When all the lines have been well cut in, the paper can be removed and the marks deepened or made wider by using a differently shaped file; the angle of a square or the edge of a very thin flat one dipped in the turpentine and camphor will make good broad lines that can easily be seen. If it is wished to number the graduations, Roman numerals are the easiest to make, but they should all be penciled on the paper and cut through, as before described. It will generally be found on trial that two or three of the small files will easily cut the surface of the glass when used at the point like pencils; and in this case any sort of numerals or letters can be engraved, provided they are first started through the paper.

The oil of turpentine should not be used until the paper has been removed, as it is important to keep the latter dry, but afterward the files will work much more easily and quickly with the aid of the lubricant. If thick, bold lettering is required, it should be drawn on the paper and the thick lines removed with a sharp-pointed penknife. In most cases it is better to cut through all pencil lines with a sharp knife before filing, as this prevents the files from becoming clogged.

If very broad lines are required, it is as well to commence them by making two thinner lines the proper distance apart; the surface of glass between the lines can then be easily chipped away with the end of a file.

There is not the slightest difficulty with any part of the operation, excepting when elaborate writing is attempted, and even this can easily be mastered by anyone who is accustomed to use the pencil. The precautions to be observed are: First mark upon the paper every line that is required to appear upon the glass, and do not remove the paper until every line has been cut, or rather scratched on the surface of the glass. Special care must be taken to insure this in the case of lettering, as it is very difficult to remedy omissions in the absence of the paper.

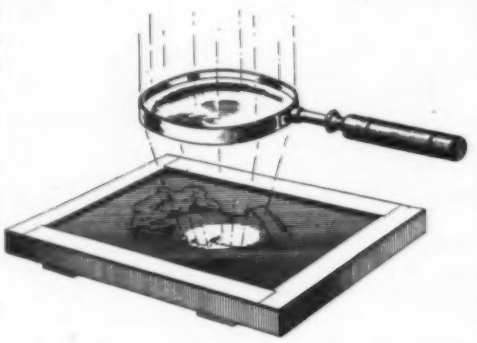
Numbers or lettering will always look neater if placed between two parallel lines, which need only be lightly scratched on the glass. These will, in a great measure, prevent the tool from overshooting the mark when deepening and picking out the body of the letters, and will also insure that the latter will all be of the same height.

If these instructions are carefully carried out, with very little practice, measures and bottles can easily be graduated in such a manner as to give no evidence of the work of an amateur engraver.—Photographic News.

PRINTING OUT WEAK SPOTS IN NEGATIVES.

By N. MONROE HOPKINS.

OCCASIONALLY the amateur produces a negative which would give excellent results when printed from, but for a light corner, or even a light and faded looking spot in a very conspicuous place. Such a negative can be printed from and the print be much improved by strengthening the light in that particular place by means of a large reading glass. The sun's rays should be concentrated on the dense part of the negative, and the glass moved to and from the negative in order not to form a round spot. With a glass measuring five or six inches in diameter the illuminated spot should vary, having an average area of that of a silver dollar, and care should be exercised not to allow the focus to get much smaller, for a fine focus and several seconds time constitute all the elements necessary to go right through the negative, making a beautiful star of cracked glass on the way.



METHOD OF CONCENTRATING LIGHT ON NEGATIVES.

Soil for Greenhouses.—After one or at most two years use, the soil of greenhouses will become unadapted to the crop and will need to be replaced. It is not easy to find just the right kind of soil to make a new bed. It ought to be very largely humus, but much richer than swamp muck ever is, for the muck fails to decay only because it is kept submerged with water so long a time that all its fertility is washed out as fast as it becomes available. It takes a whole year to properly prepare humus for the greenhouse bed. The best is made by composting sods for a year, putting in plenty of lime, which will clear away the insects likely to cause most trouble. These sods should be laid in alternation with cow manure, and some nitrate of soda sprinkled over the top, to be washed down as the compost heap is moistened. The sod and excrement will rot down together and the soil with the sod will hold the ammonia from the decomposing heap from being wasted. Besides the soil for growing plants there needs to be a large supply of coarse sand, to be kept entirely by itself to root cuttings in. The white rootlets that put out from the callous of a cutting are very tender and will not be put into soil that is very rich, and which is, consequently, always warm from the heat of decomposition.

The Supply Journal says that the Japanese have fruit ice which is cooler, and perhaps more healthful, than that which we make ourselves. It requires no machinery and no cooking. It is made for you on the street corners of Japan while you are looking. The dealer has in a box any number of chunks of ice. You give him an order and he takes out a clear, clean piece half as large as the fist, and with a coarse iron grater rubs the ice into a thick snow, which falls into a cup or goblet. He rubs up enough ice to about half fill the vessel, throws over the top of it a spoonful of powdered sugar, and squeezes into it the juice of half a lemon. He hands the vessel to you with a spoon, and you can eat it in whatever style you like. You can mix it up and it becomes like water ice, or you can pick out the ice and sugar together and consume that separately. In the place of lemon you can have, according to the season, lime, orange, pineapple, mulberry, cherry, tea or coffee. For a small cup of this simple but pleasant delicacy the charge is two cents, and for an eggcupful one cent.

SELECTED FORMULÆ.

Baking Powder.—These are some formulas taken from a paper read before the Georgia Pharmaceutical Association several years ago by Dr. George F. Payne, of Atlanta. The figures are based upon the tartaric acid selling by the ton at 25 cents a pound, cream of tartar at 22½ cents, acid phosphate of lime at 7½ cents, dried alum at 4½ cents, starch at 2½ cents, and bicarbonate of soda at 3¼ cents. That these powders should keep well, each ingredient should be first thoroughly dried by a gentle heat, and they should be kept securely closed in dry fruit jars, corked bottles or sealed cans.

(1) Tartaric acid ..... 1 pound.
Bicarbonate of soda..... 1 "
Starch (powdered)..... ½ "
Costs about 11¾ cents a pound.

(2) Cream of tartar..... 2 pounds.
Bicarbonate of soda..... 1 "
Starch (powdered) ..... ¾ "
Costs about 13½ cents a pound.

(3) Acid phosphate of lime ..... 1½ pounds.
Bicarbonate of soda..... 1 "
Starch (powdered)..... 1½ "
Costs about 4¼ cents a pound.

(4) Acid phosphate of lime..... 2 pounds.
Dried ammonia alum ..... 2 "
Bicarbonate of soda ..... 3 "
Starch (powdered) ..... 5 "
Costs about 4 cents a pound.

(5) Dried ammonia alum..... 1 pound.
Bicarbonate of soda..... 1 "
Starch (powdered)..... 1 "
Costs about 3½ cents a pound.

To the above cost should be added the cost of the containers and the time consumed in doing the work. The ingredients, all finely powdered, should be first sifted separately, to get rid of all lumps, then the soda and starch should be well mixed together, and finally the acid ingredients should be added, and all thoroughly incorporated, either by rubbing together in a mortar or by sifting at least three times. Flour can be used in place of starch, and is considerably cheaper. A recipe is given for each variety of baking powder. The amount of starch can be increased in any of the recipes, the other ingredients being left the same.—Pharmaceutical Era.

Stimulating Hair Lotion (Dieterich).—

Quinine hydrochlorate	1	drachm.
Tannin	2½	"
Proof spirit	30	ounces.
Tincture of cantharides (B. P.)	1	"
Glycerine	1½	"
Eau de Cologne	1½	"
Vanillin	1½	grains.
Sandalwood	40	"

Macerate for four days and filter.

We presume that red sandalwood is meant.—Chemist and Druggist.

Delsol's Furniture Polish.—

Sodium carbonate	100 parts.
White wax	200 "
Alcohol	50 "
Water, enough to make	3,000 "

Dissolve the sodium carbonate in 1,500 parts of the water and bring to a boil. When boiling, add the wax, broken into small bits, and continue the heat until solution is complete. Let cool down somewhat, under constant stirring, and then add, little by little, the rest of the water, and finally the alcohol. Any desired color may be given by using an anilin or any transparent color.—Drogisten Zeitung.

Tooth Wash.—Carbolic:

Pure carbolic acid	6	grains.
Borax	1½	drachms.
Glycerine	1	ounce.
Eau de Cologne	3	"
Tincture of rhatany	30	minims.

Dissolve the carbolic acid and borax in the glycerine, and add the other ingredients.—Bulletin of Pharmacy.

Brass Coloring.—A fine black color, which can be varied to a light brown, can be produced on brass by treatment with an ammoniacal copper solution made by dissolving one part of copper nitrate in two parts of ammonia of specific gravity 0·96 while keeping the solution cool. The brass articles, which must be carefully cleaned, acquire a light tone on first being immersed, but on exposure for some hours become deep black. The treatment can be interrupted when the desired tint is reached. A luster can be put on the articles by rubbing with a little wax or vaseline. The process can be varied and other color effects obtained by treatment of the article after the development of the black color with very dilute hydrochloric acid, which dissolves the coating gradually and thus modifies the tint. The composition of the brass also has an influence on the result, and the coloring produced recalls that seen on Japanese bronze, which has possibly been obtained by a similar method.

Detection of Antipyrine.—The antipyrine is removed from its aqueous solution by shaking with chloroform, the residue, after evaporating, is then taken up with water, adding sodium nitrite and dilute sulphuric acid, the solution takes on a green color in consequence of formation of nitroso-antipyrine. For quantitative estimation 0·02 gramme of antipyrine is dissolved in 25 c. c. of water, followed by 1·6 c. c. of sulphuric acid (1 per cent.) and 0·8 c. c. of sodium nitrite solution (1 per cent.), diluting with water to 100 c. c. The solution to be tested is diluted with measured volumes of water until both solutions are of the same intensity of color. —Phar. Era.

An Antiseptic Powder.—We are told by the Journal de Médecine de Paris of June 14, 1896, that the following makes a useful antiseptic powder, equal to iodoform in value, but without its odor:

Powdered iodoform,
Powdered benzoin,
Powdered cinchona,
Powdered carbonate of magnesium with oil of eucalyptus, equal parts.

This powder is also absolutely without danger.

ENGINEERING NOTES.

More than 90 per cent. of railway passengers in England travel third class. They contribute about 83 per cent. of the receipts.—Uhland's Wochenschrift.

The Daunt's Rock lightship, off Queenstown harbor, which was believed to have gone adrift in the recent gales, foundered at her moorings, carrying down her crew of eight men, as the divers recently discovered.

The firm of Gebrüder Körting, manufacturers of injectors and various other articles, near Hanover, Germany, has just celebrated its twenty-fifth anniversary. In 1871 the two members of the firm started the business with two workmen; now they employ 1,700 workmen in their factories and 370 men at their offices.—Stahl und Eisen.

To facilitate the removal of nuts from screws, it is now proposed to make the nuts with a longitudinal groove, either straight or spiral, at an angle to the threads. This permits of the introduction of oil along the threads of the screw and nut so as to readily loosen rusty nuts. The new construction also protects the threads from becoming dull or stripped.—Glaser's Annalen.

A new smoke-consuming furnace has been invented by Carl Wenigmann, of Cologne, Germany. The products of combustion are made to pass over a series of wires or bars kept incandescent by an electric current. These wires may be located in the chimney at different levels. The air is rarefied by the heat, thus improving the draught, while moisture and changes of temperature do not affect the working of the chimney. Moreover, a complete combustion is secured.—Wiener Gewerbe Zeitung.

The German naval authorities have decided to equip all the existing large men-of-war in the German navy with apparatus for heating their boilers partly with oil, and the use of liquid fuel will, it is stated, be provided for in all new vessels. The oil will be stored on board in special tanks, from which it will be conducted to the furnaces by pipes, and ejected in a spray by steam. For the storage of the liquid fuel in large quantities, reservoirs holding over 100,000 gallons have been built at Wilhelmshaven, and similar arrangements are to be made at Kiel and Dantzic.

Most machinists know how to set the machines they are handling for the kind of metal to be cut, but very few men know anything about the speed in feet per minute. We heard of a dispute that arose lately about the speed of a large planer. The machinist who was in charge of the tool, on being asked its speed, said 25 ft. while cutting and 55 returning. Several other machinists guessed at the speed, and the lowest was 22 and 50 ft. per minute. It was sold as an unusually powerful tool, that could do work at maximum speed. By actual measurement the speed was found to be 16 and 34 ft. per minute.—Locomotive Engineering.

A project is reported, says the Practical Engineer, for utilizing the power of the Danube cataracts between Kosle Doyke, on the Servian side, and the Iron Gates. The Servian government is in treaty with a certain Herr Hugo Luther, who seeks a concession giving him the right to convert the now wasted energy of the cataracts into electric current, and to supply the latter to industrial undertakings either already in operation or about to be started. Herr Luther calculates that by means of a cable in the river he will be able to transmit power to Bazias, Orsova, and Mahadia in Hungary, to Turn Severin in Roumania, and to Widdin in Bulgaria, as well as to such places in Servia as may require it. Thus, four countries would be served with electricity generated by the Blue Danube. The energy of the cataracts is estimated at 200,000 horse power; and Herr Luther asks for a concession of 100 years. In the locality the belief seems to be that the scheme will be carried out.

The fastest trains in Germany, says the Revue Générale des Chemins de Fer, are the express trains between Berlin and Hamburg. On this 177 miles of line, the grades are very easy and the curves are of large radius. Three trains daily leave Berlin and reach Hamburg in 3 h. 36 m., the average speed being 49 miles per hour, not including a stop of 4 minutes at Wittenberg and another of 1 minute at Friedrichsruh. The average speed between these last two stations is 52 miles per hour. The normal train hauled is made up of four heavy "corridor" passenger cars, mounted on trucks, and two baggage cars, on 6 wheels each; the total weight is about 133 metric tons. The locomotive has 4 coupled driving wheels, 6·56 ft. in diameter, and is provided with a leading truck. The fastest Austrian train is the "train de luxe," running between Vienna and Carlsbad. The 283 miles is made in 419 minutes, including stops aggregating 40 minutes. Deducting these stops, the average speed is about 44·7 miles per hour; this is very good, as some of the grades are heavy and the curves are sharp. The train weighs 140 tons and the locomotive 80 metric tons.

The vexed question in the theory of fluid friction, whether finite slipping does or does not take place at the surface of a solid in contact with a liquid, forms the subject of a contribution by Dr. Antonio Umani, in a recent number of the Nuovo Cimento. The experiments, says Nature, were conducted in the physical laboratory of the University of Parma, the apparatus used consisting of a cylindrical box filled with mercury, and suspended by a torsion fiber. In one series of experiments the sides of the box were nickel plated, so that the mercury did not actually wet the metal; in another series the mercury was made to bathe the sides of the box by thoroughly amalgamating the latter. In the former case the presence of a film of air between the mercury and nickel was obviated by filling the box in vacuo. The observed values for the logarithmic decrement of the amplitude of the oscillations were found to differ in the two series of experiments by an amount which, Dr. Umani considers, indicates finite slipping between the mercury and the box when the latter is nickel plated. The author further proceeds to calculate the internal coefficient of viscosity of mercury from the results of his second series of experiments, and obtains the value n = 0·01577 C. G. S. units at temperature 10° C. Warburg, employing Poiseuille's method, had previously obtained at temperature 17·2° C. the value 0·01602.—The Electrician.

ELECTRICAL NOTES.

An English company intends to construct an electric railway from Aosta to Martigny, over the St. Bernard. The gradients will be five per cent. and the highest point 7,285 feet above sea level. The cost is estimated at $8,000,000.—Uhland's Wochenschrift.

One hundred thousand horses running wild, because electric cars and bicycles have cut them out of occupation, are proving a pest in Washington State, and the farmers are hoping for a hard winter to kill them off. This fall whole bands of them have been sold for one or two dollars apiece.

"The Lachine Rapids of the St. Lawrence are at last to be utilized," says the Yale Scientific Monthly. "For some time work has been prosecuted on a large wing dam that runs out more than a thousand feet into the St. Lawrence River. A fall of water is secured by this means of 15,000 horse power. This water power is to be transformed into electricity. Upon the dam a power house will be built to run its entire length and show an unbroken interior of 1,000 feet in length."

One of the London theaters is now heated by electricity. After trials with four radiators had been successful, fourteen additional radiators were supplied. A current of 96 amperes and 100 volts is employed, the temperature obtained being about 60° Fahrenheit. The first cost of the plant is not less than that of any other heating system, but the running expenses are very low, amounting only to 16 shillings a day. The danger of fire is also considerably lessened.—Uhland's Wochenschrift.

The first normal gage electric railway in Europe has been in operation for about a year. The line is 2·8 miles long and connects the towns of Meckenbeuren and Tettnang in Würtemberg. Power is derived from Jonval turbines of 120 horse power, of which 75 horse power are used for the railway and the balance for the electric lighting of Tettnang. A steam engine is provided, so that there is a reserve of power for emergencies. Overhead conductors are used, and the rails are employed for the return circuit. There are twenty-six regular trains daily, and with a train weighing 46 tons the speed attained is 14 miles an hour on gradients of 1 in 500, and 10½ kilometers on gradients of 1 in 50.—Glaser's Annalen.

The great opening in the present state of the electrical industry is for design rather than new invention. The man who can design machinery in such a way as to save 5 per cent. in the cost of materials or labor is always valuable. He must be versed in detail and capable of readily grasping the commercial details of the subject. The question of commercial efficiency also comes largely into the design, and the manufacturers who can maintain the reputation of their apparatus for smooth working and durability are sure to succeed. Hence, says the Electrical Engineer, while striking departures from existing practice may bring success to one man, two others will make fortunes by being able to get the best results at the least cost from everyday types.

A report has been prepared, says the Electrical Engineer, as to the cost of electric lighting in various places throughout Ontario: Chatham, sixty-five lamps, all night, 23½ cents each per night; Brantford, fifty-five lights, all night, 23 cents; Cobourg, twenty-three lights, till midnight, 21 cents; Port Hope, thirty-three lamps, till midnight, 15 cents; Peterboro, all night, 25 cents; Kingston, one hundred and five lights, all night, 24¼ cents; Ingersoll, thirty-six lights, till midnight, 20 cents; Woodstock, seventy lights, till midnight, 19 cents; Belleville, sixty-one lights, all night, 24 cents; Galt, fifty lamps, till midnight, 23 cents; Hamilton, three hundred and sixty-nine lights, all night, 25 cents; Guelph, ninety lights, all night, 24½ cents; Owen Sound, thirty lamps, all night, 30 cents; London, three hundred lamps, all night, 30 cents.

The Elektrotechnischer Anzeiger describes an electric plow built by a firm of agricultural machine manufacturers in Halle, says the Electrical Review. A 12 horse power portable engine and dynamo generate the electricity, which is led to the twin share tilting plow. The connection wires to the motor on the plow rest on supports, and their distance from the furrow is automatically maintained by the contact arm. The ends of these wires are connected through a cable car to the dynamo. The dynamo delivers twenty-five amperes at 400 to 500 volts. The motor on the plow makes 500 revolutions, and drives a chain wheel at 160 revolutions per minute. This chain wheel works along a chain laid out in the field, as in the case of a steam plow. A furrow ten inches deep and 400 yards long was cut in about six minutes. Three men are required to manage the apparatus, one sitting on the plow and the other two at either end of the furrow, to move the cable cart and the anchors which hold down the chain. The following proportional figures are given: Cost of working electric plow, 5·5; cost of working steam plow, 10; cost of working plow drawn by oxen, 12·5.

Work is proceeding satisfactorily on the massive new dam of the St. Anthony Falls Power Company, in the Mississippi River, at Minneapolis, says the Engineering and Mining Journal. The Twin City Rapid Transit Company will utilize the power obtained from the new dam—estimated to be 10,000 horse power—and transmit it electrically, and the engineers are now going over the details of the project. The St. Anthony Company will install ten horizontal turbines of 1,000 horse power each; and these will be directly connected to a like number of alternating current generators by the Twin City Company, which leases the power at the water wheels. The electrically transmitted power will be used to operate the cars on the extensive electric railway system of St. Paul and Minneapolis by means of rotary transformers. If there is more power than is needed for this purpose, it will be sold or utilized in other ways. The Twin City Company will furnish the electrical apparatus, and alternating current machinery offered by the General Electric, Westinghouse and Stanley companies is under consideration. The distribution will probably be underground, and the existing steam plants will be retained as reserves. When completed the plant will rank as the second or third largest water power transmission in the country.

MISCELLANEOUS NOTES.

Edison's French patents for the phonograph have been declared void, upon the ground that the patentee did not comply with the requirements of the law concerning the manufacture of the patented articles in France.—La Propriété Industrielle.

More than 50 per cent. of the applications for British patents are never completed. Of the patents granted, about 70 per cent. expire on account of the nonpayment of the first tax, at the end of the fourth year. Only about 6 per cent. of the patents granted are kept alive for the full term of fourteen years.—La Propriété Industrielle.

For those who believe in the fatality of the number thirteen, the American quarter dollar is about the most unlucky article they can carry on their person. On the said coin there are thirteen stars, thirteen letters in the scroll which the eagle holds in its claws, thirteen feathers composing its wing, thirteen feathers are in its tail, there are thirteen parallel lines on the shield, thirteen horizontal stripes, thirteen arrowheads, and thirteen letters in the words "quarter dollar."

Quarrying with lime has been used in England instead of blasting. The lime is formed into bars of about 70 millimeters (2¾ inches) diameter, under a pressure of about 40,000 kilogrammes. An iron tube, provided with a longitudinal slit and numerous perforations, is then put into the stick of lime, so as to protrude from it at one end, and the whole inclosed in a canvas bag is put into the hole drilled in the rock. The protruding end of the iron tube is then connected to a pump and the end of the hole is closed with clay. Upon the injection of water the lime expands with considerable force (vapors of about 250 atmospheres being generated) and dislocates the rock. This method is very cheap and absolutely safe.—Baumaterialienkunde.

The following table, says the Philadelphia Record, gives the number of deaths from typhoid fever per 100,000 inhabitants in European cities having a purified water supply and in American cities where the water supply is polluted by sewage and other filth:

Europe.		United States.	
Berlin	5	Chicago	32
Munich	3	Cincinnati	36
Hamburg	9	Cleveland	36
The Hague	5	Washington	74
Rotterdam	2	Pittsburg	77
Stockholm	9	Jersey City	71
Christiania	7	Louisville	77
Vienna	6	Indianapolis	97
Dresden	5	Philadelphia	40
Breslau	9	Buffalo	29
Average	6	Average	56·9

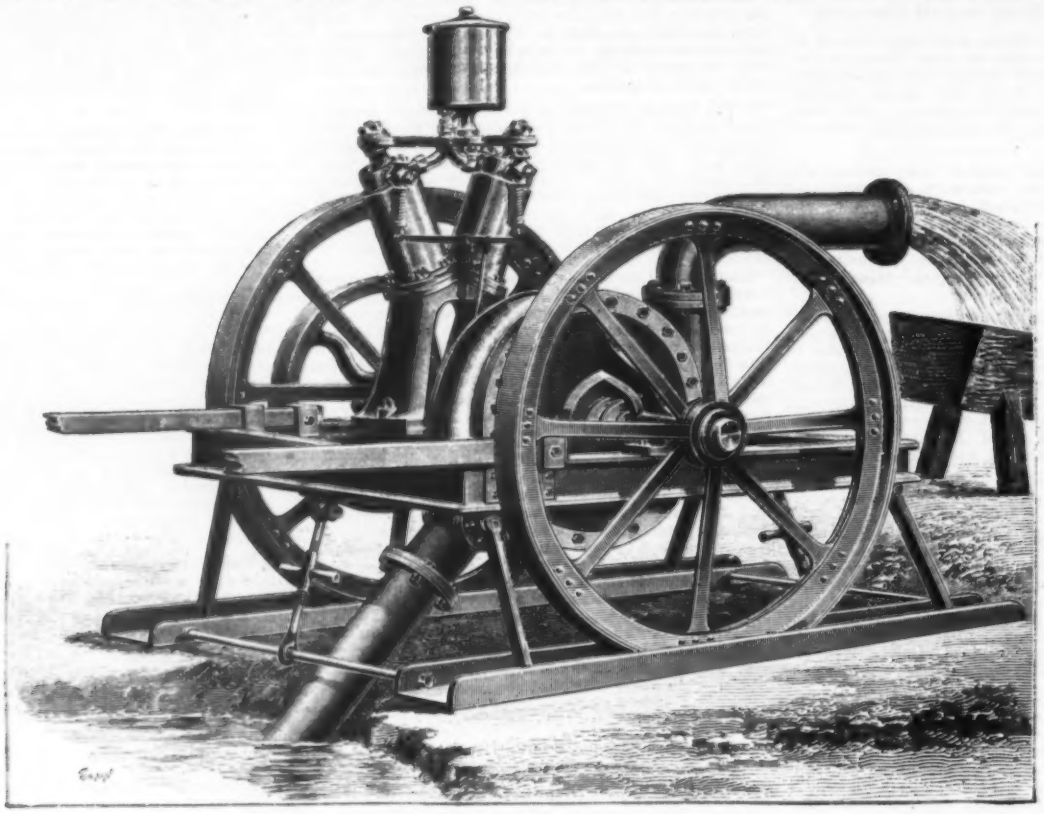
An estimate of the possible profit to be realized in utilizing pine stumps and pitchy waste may be made, according to the Lumber World, by assuming that every cord of fat pine will yield forty bushels of the best quality charcoal, twenty gallons of turpentine, forty gallons of tar, forty gallons of tar oil, and sixty gallons of pyroligneous acid. By a process of redistillation this pyroligneous acid will yield one and one-half to two gallons of alcohol, with from four to six gallons of acetic acid, besides a quantity of creosote. Calculating these first five named products at the lowest usual price, the returns from a cord will net $15. Young sap wood will yield more than one-half this quantity of products. A plant for this purpose can be built in the shape of retorts, each retort of sufficient size for one-half cord of wood, at an outside expense of, say, $300. The time required for each charge of one-half cord of wood is eight hours, each retort thus handling one and one-half cords of wood in twenty-four hours, resulting, therefore, in some $20 profit per day from a retort costing not more than a coke oven.

A small instrument, the invention of Major Heath, will, it is stated, make the forging of bank checks an impossibility, inasmuch as the depositor's signature is done away with, and the signature on the check to be honored ascertained by the location of perforated holes on a paper disk that is presented by the payee. The instrument consists of three gun metal rings, which revolve round a central piece; these rings carry little punches on their under surface for making small holes in the check. The rings are divided by deep slots on the upper surface, all radiating from the center into segments, each division being engraved with a letter or figure. A small bolt holds a combination of letters or figures on the three circles in their place, and, this secured, the pressing of a handle causes the punches to perforate the paper placed beneath them. The holes thus formed make a combination only known to the person issuing the check. The check itself, with its perforated attachment, is sent to the bank, and a similar perforated piece of paper forwarded to the person for presentation. The invention will be found especially valuable in the case of letters of credit.

The production of wood pulp carpet lining is mentioned in the Manufacturers' Gazette as an additional novelty to the many already furnished by that material. The chief factor in this process is a special preparation of the previously worked pulp, which requires the use of a series of cylinders. During the passage of the pulp through these cylinders it receives the ingredients which render it porous, firm, pliable and efficient for the purpose intended. In connection with these is a retort containing fluids of an albuminous nature, which become turbid, evolving carbonic acid; the fermentation resulting is what is wanted to give the pulp a porous condition, and this fermenting fluid is allowed to add itself to the flow of pulp in correct proportions. A mixture made of asafœtida, camphor and chicle serves as a mothproof compound when mixed with pulp—a tank connects with the apparatus, which contains compounds, including the well known hardening chemicals and ingredients—and the right proportions are introduced and mingled with the pulp. Monobromated camphor and menthol are run in, if it is desired to impart an agreeable odor to the pulp. The continual working of the pulp through these cylinders and pipes imparts to it that elastic element so desirable for a carpet foundation, and, if well done, the carpet is like rubber.

A PETROLEUM IRRIGATION PUMP.

THE Pennington Motor Syndicate, Limited, of England, has made quite a new departure in pumping machinery which is especially designed for irrigating purposes, although it lends itself for a variety of other uses as a stationary engine. Our engraving represents a plant capable of delivering 20,000 gallons of water per hour to a height of forty feet. The whole plant is so compact and light that it can readily be transported by two men. The design, we are informed, was got out at the request of a prominent member of the Egyptian government, and large orders are in hand for Egypt and our colonies. Sizes ranging from 5,000 to 130,000 gallons capacity per hour are in course of construction. We are indebted to Industries and Iron for cut and particulars.



PETROLEUM IRRIGATION PUMP.

THIRTY TON STEAM LOCOMOTIVE CRANE.

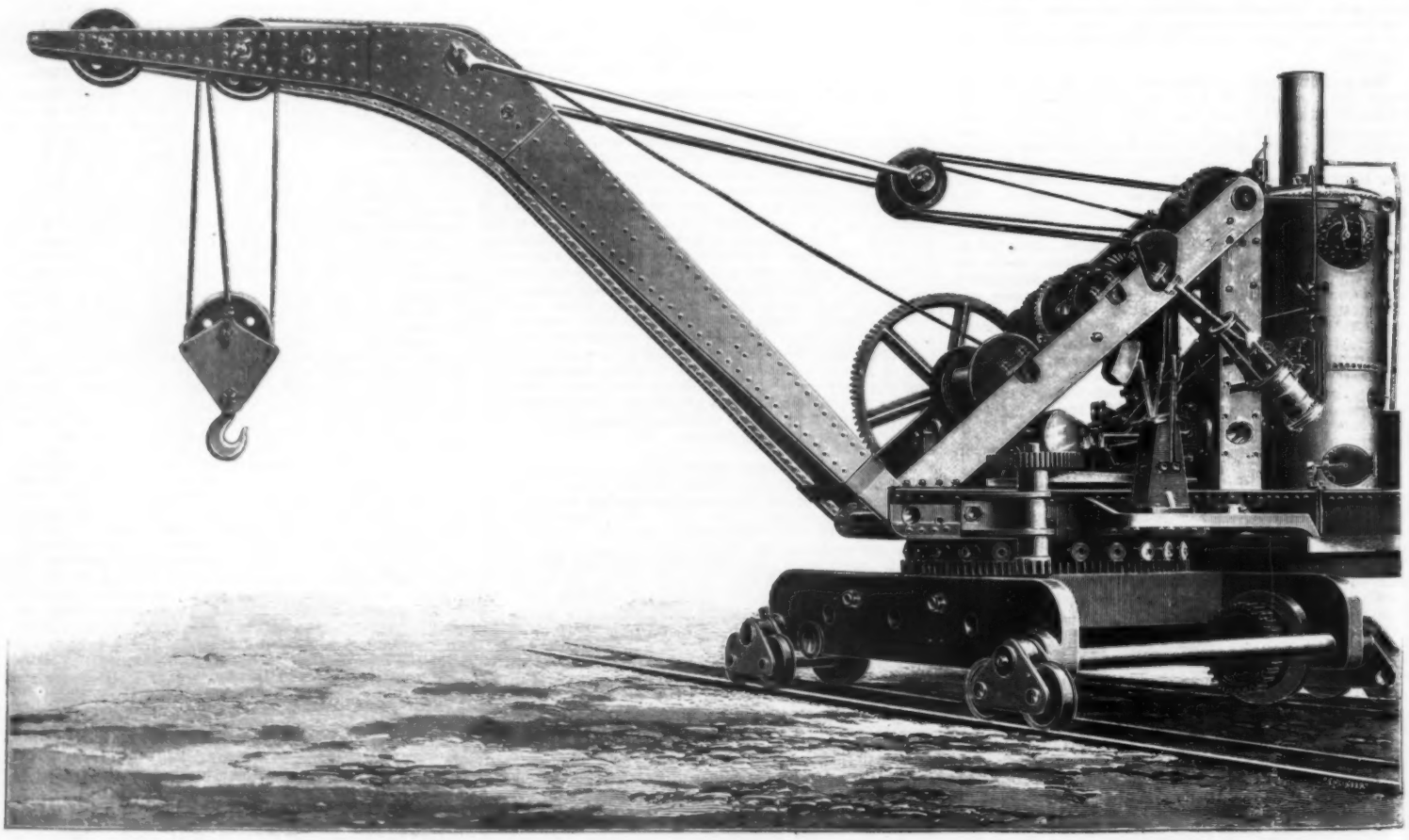
WE give an illustration of a heavy locomotive crane recently built by Messrs. John Grieve & Co., of Motherwell, Scotland, for Messrs. William Beardmore & Co., Parkhead Steel Works, Glasgow. This crane is capable of lifting and traveling with a load of 30 tons at a radius of 17 feet, and is employed in lifting heavy ingots out of the heating furnaces and carrying them to the rolls to be rolled into armor plates. The crane carriage is of heavy construction, the sole plate being of cast steel with a forged steel pin through the center. It has twelve wheels running on four rails, the wheels on the outside rails being coupled in pairs so as to distribute the pressure on the rails.

The frame carrying the gearing is made of heavy steel bars, into which are fitted the gun metal bushes for the shafts, with covers and bolts, so as to be easily removed. The various motions are wrought by two pairs of engines, one pair working the hoisting and derricking motions and the other pair the revolving and traveling motions. The hoisting motion has two speeds, the full load is lifted by a triple rope of plow steel and a powerful foot brake is provided for controlling the load. The derricking or jib-adjusting motion is wrought by a worm and wheel. The jib is built of steel plates and angles.

As this crane has to work under a low roof, the jib is bent and extra pulleys provided, so that when required loads can be lifted at greater radii without lowering the jib. The crane revolves on twenty-four steel antifriction rollers running on turned steel roller paths. The traveling motion is driven through the center pin, the four wheels on the inside rails being coupled by gearing.

All the gearing is of Siemens cast steel, the engines have balanced cranks of forged steel. The boiler is of the usual vertical type, having cross tubes in the fire-box, and is designed for a working pressure of 80 pounds per square inch. The total weight of the crane is about 60 tons.

This is a very fine, well-designed machine, and is one of the largest—if not the largest—and heaviest traveling jib cranes in the world.—Engineer.



THIRTY TON STEAM LOCOMOTIVE CRANE.

An explosion of acetylene gas, used for lighting in a Lyons café, completely wrecked the café, severely injured three persons who were in it at the time, broke every pane of glass in the building, which is four stories high, and tore off the doors from their hinges on the first two stories.

THE DE DION & BOUTON GASOLINE TRICYCLE.

THE third race of automobile vehicles, that of Paris-Marseilles Paris, of which we have already spoken to our readers, revealed to the public the very remarkable features of speed, power and endurance of the gasoline tricycles that Messrs. De Dion & Bouton have been constructing for nearly two years. Despite its apparent frailty, one of these light vehicles was the third to arrive, beating a goodly number of its large and powerful competitors and making the long trip of 1073 miles, despite wind and storm, in 71 hours, at an average speed of 14 miles an hour. This magnificent performance puts Messrs. De Dion & Bouton's vehicle in the first rank of automobile tricycles and affords us an occasion to give as complete a description of it as possible.

This tricycle, of which Figs. 1 and 2 give side and rear views, belongs to the class of mixed automobile vehicles actuated separately or simultaneously by the muscular strength of the cyclist or the mechanical power produced by a gasoline thermic motor. Its general aspect is that of an ordinary tricycle, with reinforced tubes and strengthened fork for assuring its rigidity and resistance. The spacing of the two hind wheels is 36 inches and the total weight of the vehicle is 176 pounds. The wooden or steel wheels with tangent spokes are provided with Michelin pneumatic tires. The pedals act upon the toothed wheel that they control through the intermedium of a clutch that transmits the pressure exerted upon the pedals to the hind wheels only when the velocity of the pedal axis exceeds that of the latter. It is therefore possible to cease to pedal at any instant without the stoppage of the pedals acting in any way to slacken the speed communicated to the tricycle by the motor. The progressive or sudden stoppage of the running of the vehicle is effected by acting upon two brakes, one of them with a spoon that acts upon the tire of the front wheel and the other with a leather covered elastic band that acts upon the axle of the driving wheels, which are connected by a differential train.

FIG. 1.—SIDE VIEW OF THE DE DION & BOUTON TRICYCLE.

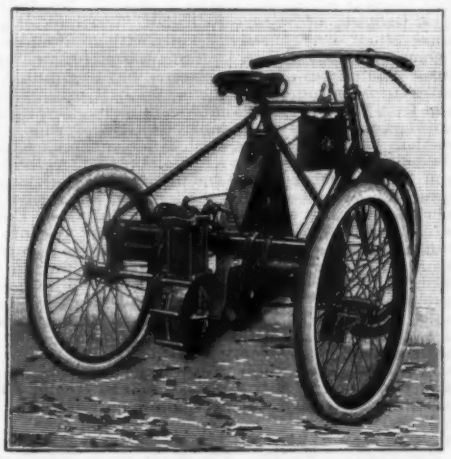


FIG. 2.—REAR VIEW OF THE TRICYCLE.

The motor consists essentially of a carbureter, of an explosion cylinder and of an electric igniting device that we shall describe in succession through the aid of Fig. 3, which shows diagrammatically the connections of the essential parts of the motive system.

The Carbureter.—The carbureter, which is of triangular form, is placed directly under the saddle. It consists of an iron plate reservoir, C, partially filled with gasoline of a density of 0·7. Into this reservoir enters a vertical tube, T, through which the external air flows and which terminates in a metal plate, I, arranged horizontally above the gasoline. A float, F, makes known at every instant the level of the gasoline in the carbureter. The air entering through the tube and guided by the plate, I, impinges upon the surface of the gasoline and becomes saturated therewith. The air charged with gasoline ascends to the upper part of the carbureter, where it meets with two cocks with horizontal axis. One of these cocks, R, permits of the admission of air from the exterior, of air charged with gasoline, or of a mixture of the two into the second cock, R', which leads it to the cylinder of the motor. The cartouche at the bottom of Fig. 3 shows this cock in section and allows the arrangement of it to be understood. These cocks are controlled by means of two distinct handles arranged within reach of the hand upon the horizontal part of the frame. The cyclist thus, with a single hand, regulates both the composition of the explosive mixture and the proportion in which the mixture is admitted to the cylinder at every instant.

The Motor.—The motor is of the type called four-period—suction, compression of the mixture, explosion, and expulsion of the products of combustion. The cylinder, D, of the motor is arranged vertically and provided with a large number of wings cast in a piece with it. During the running of the tricycle the surrounding air impinges upon these wings and cools them to such a degree that there is no need of carrying a supply of cooling water, which would needlessly add weight to the vehicle. The distribution of the gas in the single acting cylinder is effected through two valves, S and S', arranged at the side of the cylinder at its upper part.

The suction suffices to actuate the feed valve, S', which is held upon its seat by a spiral spring. The eduction valve, S, is controlled by a cam, G, with a special arrangement of reduction through gearings that permit of raising the valve only once at every two revolutions. The noise at the exhaust is reduced to nearly a minimum by causing the spent gas to enter a cylinder, B, in which it expands and then passes out into the atmosphere through a few small apertures formed in the lower part of the expansion cylinder. In Fig. 3 this cylinder is represented as vertical, but in reality it is fixed horizontally upon the left side of the tricycle frame.

It is the suction caused by the running of the motor that introduces the air into the carbureter, and thus produces the explosive mixture of variable richness that is to be utilized a moment later. The evaporation of the gasoline tends to cool it and, consequently, to reduce its volatilization. This inconvenience is remedied by causing a portion of the hot gas coming from the exhaust to pass through a sinuous pipe, A, placed in the carbureter. The piston, driven downward by the explosion once every two revolutions, acts, through the intermedium of a rod, upon the crank pins of two flywheels revolving in a cylindrical aluminum box filled with oil, into which plunges the head of the piston at every revolution. The stirring produced by the revolution of the shaft assures an abundant lubrication of the cylinders.

The axis of the flywheels is prolonged upon the right side outside of the box and carries a pinion, P, which meshes with a cog wheel mounted upon the axle of the hind wheels. This same axle carries the differential train that permits the two wheels of the tricycle to describe different paths or curves, and also the sprocket connected with the axis of the pedals, through a chain, for starting the motor and for the momentary aid to be given it by the cyclists in pedaling upon rising ground, for example. The normal speed of the tricycle is 12 miles an hour, corresponding to 1,400 revolutions a minute of the motor shaft, or 700 explosions a minute.

The supply of gasoline is about one gallon. According to the difficulties of the road, this gallon of gasoline permits of making from 40 to 60 miles. The ignition accumulators have a capacity sufficient for a continuous run of 150 hours, say 1,800 miles. The speed upon a level may reach as many as 20 miles. A cyclist whose weight does not exceed 220 pounds may ascend gradients of from 4 to 5 per cent. without the aid of the pedals. He can naturally ascend them more quickly with the pedals, and, with their aid, can even ascend gradients of from 10 to 12 per cent.

The driving axle is prolonged on the left side of the tricycle, and, through gear wheels, actuates an intermediate shaft upon which are mounted the cam, G, that controls the eduction valve, S', and the cam that controls the electric ignition.

The Electric Ignition.—The electric ignition device adopted is quite novel. The ignition is effected by means of an induction coil supplied by two small accumulators arranged in a rectangular box suspended from the upper brace of the tricycle (Fig. 2). The circuit of this induction coil is opened or closed at the proper moment by an ignition cam mounted upon the axis that controls the eduction valve and that revolves with half the velocity of the driving axle. A combination of levers permits of shifting the cam upon the axis that controls it and of causing the ignition spark to appear at the moment of the piston stroke that corresponds to the best conditions of performance. The ignition is effected very simply by leaving upon the secondary circuit of the induction coil a space, T, of 0·04 of an inch between two platinum wires arranged at the top of the cylinder. One of these wires communicates directly with the mass, while the second is insulated in a small porcelain tube. The primary circuit is opened or closed by maneuvering an interrupter arranged in the left grip, M, of the handle bar. The circuit is opened by revolving the grip, M, in one direction and is closed by revolving it in the other.

The starting, regulation of the speed and the stoppage are exceedingly simple operations. For starting, the cyclist opens a small cock, N, arranged at the upper part of the cylinder, and the object of which is to suppress the resistance produced by the compression of the air when the tricycle is set in motion by means of the pedals before the first explosion. The cyclist assures himself that the electric ignition cam is properly placed, that the regulating cock of the carbureter is in a medium position, and that the feed cock is wide open. He then pedals vigorously and closes the electric circuit of the accumulators upon the primary circuit of the induction coil, by turning the left hand grip of the handle bar in the proper direction. There then occur two explosions that are clearly perceived through the open cock above the cylinder, which is then closed and not touched again until the next starting occurs.

In order to regulate the speed, the cyclist acts upon the quantity of gas sent to the cylinder, upon the richness of the mixture and upon the ignition cam. After a few tentatives, these three regulations are very easily effected, and the velocity with which the motor runs shows the experienced cyclist which of the three factors it is well to modify in order to secure at every instant the best conditions of operation and rendering.

To stop the machine, the electric ignition current is first interrupted by turning the grip of the handle bar in a direction opposite that for starting, and the brakes are tightened, the spring brake with the left hand and the ordinary one with the right. In a continuous descent of some duration, each brake should be tightened in succession in order to spare the parts under friction and prevent an excessive heating either of the front pneumatic tire or of the brake pulley keyed upon the driving axle.

The cock that is opened at the upper part of the motor to effect the starting serves likewise for the lubrication of the cylinder at the time of a stoppage of some little duration. The gasoline introduced through this cock lubricates the piston rings and prevents them from adhering to the cylinder.

From the above description will be seen how simple are the means brought into play in the De Dion & Bouton tricycle. We should like to expatiate upon the perfection of the details and show how deep is the study to which each has been subjected, but space is wanting. Between the automobile bicycle and the horseless carriage, this tricycle gives the long expected solution of the question of a mechanically propelled individual vehicle.—E. Hospitalier, in La Nature.

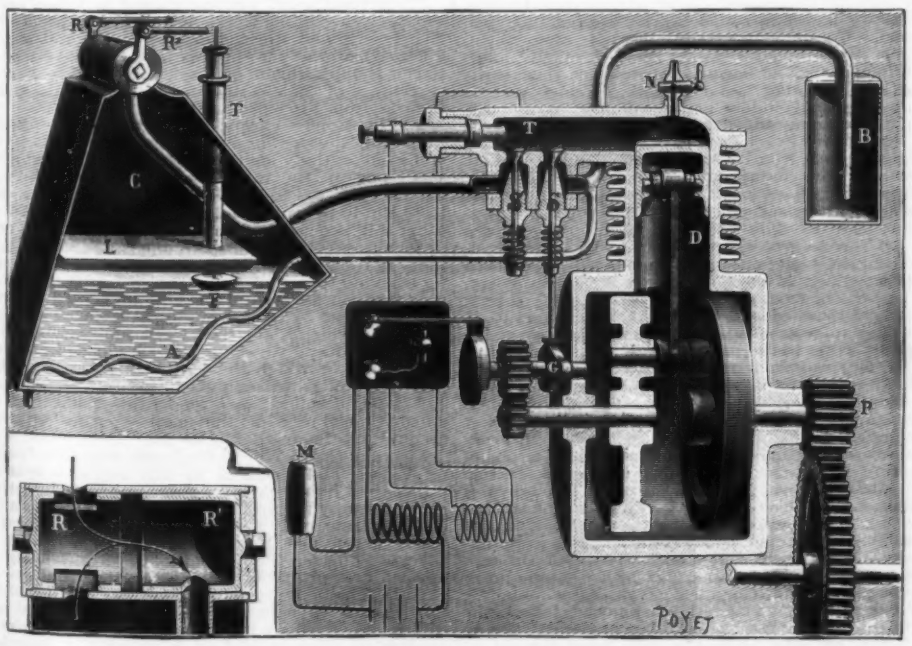


FIG. 3.—DIAGRAM OF THE MOTIVE SYSTEM OF THE TRICYCLE.

The report of the special commission appointed by the Dutch government to discuss the scheme of draining the Zuyder Zee has just been submitted. It states that such an undertaking is quite possible of success. The work would take thirty-one years for completion, and every year 10,000 hectares of land would be restored to cultivation. A dike thirty miles in length would have to be constructed, extending from the extreme end of South Holland to the eastern coast of Friesland. The building of this dike, which will be a width of 35 meters at the base and 6 meters high, will take nine years. The total cost of the work is estimated at £26,000,000, which includes the amount to be paid in indemnities to the fishermen of the Zuyder Zee. The total value of the land thus grasped from the ocean is estimated at £27,000,000, so that the Dutch treasury will net a profit of a clear £1,000,000, without reckoning the substantial gain to the public wealth and a corresponding increase in the annual revenues from duties and taxes.

THE PRESENCE AND SIGNIFICANCE OF BACTERIA IN AIR, WATER AND FOOD, AND THEIR RELATION TO HEALTH.*

By WILLIAM D. SUMPTER, M.D., Nashville, Tenn., Professor of General, Descriptive and Surgical Anatomy and Microscopy in the Medical Department of the University of Tennessee.

IT was in 1675 that Leuwenhoeck, the Dutch naturalist, observed micro-organisms in fæces and putrefying matter, by means of his magnifying glass. The crude lens did not suggest that still smaller organisms, endowed with life and function, would be revealed by the improved microscope of the subsequent centuries. In marked contrast to his larger fungi, yeasts and moulds, there have been found and demonstrated to the world plants belonging to the class of fission fungi, minute rods called "bacilli," one micron or 1-25,000 of an inch in diameter, and only two or four times as long; also small, round bodies called "cocci," varying from 1-25,000 of an inch, more or less, in diameter.

For nearly a century the discovery was almost entirely ignored, but in 1773 Muller attempted to classify the organisms found in impure water. In 1859 Davaine discovered that bacteria are plants, and gave them their place in the vegetable kingdom; also demonstrating their etiological relation to specific diseases. It remained for Lister, Koch and Pasteur, with others, to prove what has been called the germ theory a misnomer, and establish what is now known as the science of bacteriology.

Notwithstanding repeated conclusive proofs, the profession was slow to acknowledge the importance of bacteria, but so thoroughly have our colleges, textbooks and journals directed their attention to the subject, explained pathology hitherto obscure, that the physician who is loth to accept bacteriology as a scientific study practices medicine under the cloud of prejudice and is not in keeping with the progress of the times. The idea of spontaneous generation, in its absurdity, has been disproved, and we understand fully the reproduction of bacteria, as we do other plant life, the bacilli multiplying by fission, and producing, in some instances, seed or spores as distinctly as the higher vegetable kingdom; the cocci reproducing themselves by fission only.

So exact has been the study of each organism that 489 distinct varieties have been described.

As the poppy in the higher vegetable kingdom produces opium and the strychnos nux vomica strychnine, so some bacteria form definite poisons or ptomaines. This fact has led to the erroneous belief among many of the profession and the public that bacteria are all pathogenic and man's greatest enemies, while of only relatively a small number this is true, as the majority of bacteria are non-pathogenic and harmless. They may well be called the world's greatest benefactors.

To a class called saprophytes is imparted the power of converting dead organic matter into its component parts, carbon dioxide, water, ammonia, etc., to be used as food by the higher plants. Without bacterial flora all vegetable life would cease, and animal life dependent upon it would find no means of subsistence. To the saprophytic bacteria, then, all life owes its existence.

Parasitic bacteria are pathogenic, as are some of the saprophytes, but most of the latter are concerned in the decomposition of dead matter.

Wherever life is found, bacteria are present, and, as putrescible matter increases, they increase. So density of population demands attention to sanitary surroundings. The wide distribution of germs, their number and relation to health have all been carefully studied.

We will first consider the bacteria of the air. No air is free from them, except that above the snow line upon mountains or at sea beyond ships and lighthouses. Air at rest contains few or no bacteria, but such a condition seems impossible when we consider how the most insignificant breeze may hurl into the air millions of them. They are seldom isolated in the air and are usually found clinging to particles of dust, and by this means carried into the atmosphere.

In rooms they are more abundant than in streets, and in cities more than in the country, where grass keeps the air, to some extent, free from dust. Rainfall decreases the number in the air and increases the number in the water. The purity of the atmosphere depends upon the purity of the soil. Bacteria in the air are mostly cocci and mostly saprophytes.

The number necessarily varies much from less than a hundred to thousands to the cubic centimeter, according to the amount of dust held in suspension, and has no special significance, unless the bacteria are pathogenic. We shall not consider the non-pathogenic bacteria. There are quite a number of diseases which are supposed to be transmitted to us by air, as scarlet fever, smallpox, diphtheria, etc.

As the specific germs of these diseases have not as yet been found in the air, we will consider those which have been found as causes of diseases and cultivated, e. g., streptococcus pyogenes, staphylococcus pyogenes, bacillus influenzae and bacillus tuberculosis. The germs of the air, of course, are most likely to affect the lungs. The majority, however, do not pass the larynx, and, if they do, are usually deposited in the smaller bronchi, at the junction of the tidal and complemental air. Of all the pathogenic germs in the atmosphere, the bacillus tuberculosis is the most virile, and should demand our attention, especially as one-seventh of the human race dies of tuberculosis.

The relation of germs to health always depends, to a great extent, on the condition of the tissues, and impaired vitality, due to the lack of nutrition, and unhygienic surroundings, which predispose the tissues to the action of the smallest number of bacteria. Their entrance into the lungs is especially favored by the destruction of bronchial epithelium, as after bronchitis, from any cause, such, for example, as measles; by tenacious mucus, rendering the secretions less easily expectorated; by pleuritic adhesions, deformed thorax, which, for the same reasons, predispose the lungs to infection by germs. As bacteria are usually deposited in health in the smaller bronchi, they are no doubt often expectorated or destroyed before they can produce their injurious effect. That the lungs are more easily infected than the alimentary canal is shown by the experiment that when sixty-six guinea pigs were made to breathe dust containing spores of the bacillus anthracis, fifty died of anthrax, nine of pneumonia, and seven lived. By the mouth, double the amount for each was given in food to thirty-three guinea pigs, and only four died. Knowing the danger of inhalation of pathogenic germs, too much importance can not be attached to disinfection of all contaminated matter and preventing their final conveyance to us in dust.

Water has given us the best means of studying bacteria, and no water, as we find it, is free from them. Artesian wells and deep springs are nearly so. As in the air, most of the bacteria in water are saprophytes, and non-pathogenic. When bacteria are absent, as in sterilized fluids, fermentation does not take place. For multiplication in water, germs require a certain amount of organic matter, although some require very little, and can reproduce themselves even in distilled water. Very few, however, have this power. The number of bacteria in water usually indicates a proportionate amount of organic impurity, and is relatively small or great as organic matter is present. The majority of bacteria of water are bacilli. Currents of air, rains, sewers, etc., constantly contribute an abundance of them to water. In all its forms water contains bacteria. Snow from Norway glaciers has been found to possess quite a number of them, and hail usually contains from 729 to 21,000 to a cubic centimeter. Ice, unless manufactured, always contains bacteria varying from less than 100 to 14,000 to a c. c. Hudson River ice usually contains about 398 to a c. c. Hydrant water has from 200 to 4,000 or more, and may even block water pipes. This can be readily understood when we consider the rapidity with which bacteria divide. Complete division, with the offspring becoming parents in from ten minutes to an hour or more, renders this possible. Supposing a bacterium occupies an hour in division, in twenty-four hours, if nutriment were favorable, there would be more than 16,000,000 germs produced, and in two days 281,000,000,000. Reservoirs are often several feet deep in bacteria. The number of bacteria in river water may be judged by the following examinations: The water of the Seine before reaching Paris contained 1,200 to each c. c. At St. Denis, after receiving the sewage water, the number was found to be 200,000 to a c. c. The Spree in Berlin, above the Panke, contained 940,000 to the c. c.; below the mouth of the Panke, 1,800,000. The Main, above Wurzburg, contained 530; below, 15,500. The Potomac, estimates being made at different months of the year, contained from 144 to 3,774 to the c. c. Lake water has fewer bacteria than river water. Sewers in Paris have 6,000,000 germs to each c. c. of water; those of London have 7,500,000.

As with bacteria of air, enumeration of germs of water has given results mostly of scientific interest, and no additional process of practical value. We conclude, by experiment, that water containing less than 100 bacteria to a c. c., and filtered usually does, is presumably uncontaminated and safe enough to recommend. Five hundred present must be looked upon with suspicion, although all may be non-pathogenic and the water practically pure. One thousand or more to a c. c. indicates contamination, probably by surface water, and such water should be rejected or filtered. Yet, with one glass of pure spring water, we carry doubtless more germs into the alimentary canal from the buccal cavity than would exceed the most impure river water. Fortunately, however, most of these are harmless.

Eighty-seven varieties of bacteria have been found in water near Vienna. The non-pathogenic saprophytes, no doubt, are food to our bodies, as the higher vegetable kingdom. The pathogenic ones demand our attention because of their irritation to the alimentary canal and the system in general, and wounds infected by water containing them. Among the pathogenic bacteria in water in our country stands first the bacillus typhosus, very common and most resistant. Then in abundance we find the staphylococcus pyogenes aureus, the streptococcus pyogenes, the bacillus coli communis and the dreaded bacillus tuberculosis. In the struggle for existence the non-pathogenic germs usually found in water often crowd out the pathogenic bacteria, so that the greater portion die or their reproduction is prevented, thus favoring good water.

Bacteria of food are usually very abundant, and every object of nature is covered with them, and articles that serve for our pabulum are equally good for the development and sustenance of the microbe. Milk, although sterile from an undiseased udder, always contains bacteria, as we find it in use, being an excellent nutrient material. Contamination from desquamated epithelium, of the milkman's hands or cow's udder, dust raised in a hotbed of bacteria, a stable or shed, easily explains the number found in milk. Water used in washing the hands, udder and receptacles, to say nothing of the amount added to increase the quantity of milk, can convey every form of bacteria that the water contains. Milk from cows in clean and well kept stables has been found to contain from 350 to 30,500 bacteria to each c. c. The average from several samples from the stables of the suburbs of Boston was 69,143 to the c. c. The average from milk wagons was 2,355,500; from groceries, 4,577,000. The milk from Halle contained the enormous amount of 6,000,000 to 30,000,000, which is more than any American sewer. The bacteria of food are necessary to a great extent, the same as those of water. In milk the typhoid bacillus is most to be dreaded. Contamination may be imparted by water in the ways just described; also from the air, but not from the cow direct. The tubercle bacilli are conveyed direct, if the udder is tuberculous, not otherwise; also direct by meat containing tubercular glands, or by tubercular lung, if eaten. Indirectly they are conveyed by air, water and milk. In every three cases of pulmonary tuberculosis there is one of ulceration of the bowels from tubercular bacilli, carried to the alimentary canal from the mouth. In most cases of tuberculosis, infection is carried directly from man to man. The unfavorable acidity of the gastric juice, due to free hydrochloric acid, renders the stomach comparatively free from germs, but many are hurried through in food, or as spores are unharmed by the gastric juice. The duodenum and remainder of the canal are never free from multitudes of bacteria. In newborn infants the meconium contains no bacteria, but in from twelve to eighteen hours after birth the milk fæces contain an abundance of yeast and cocci. The bacillus coli communis is the most common in the bowel, and may enter the body and cause disease. The many ways that food, raw or half cooked, may be infected renders the alimentary canal always liable to multitudes of bacteria. Most saprophytes in the bowel are of themselves harmless, but some are pathogenic by their effect upon food prior to ingestion. Milk, cheese, sausage and meats, by ptomaines formed in them, are irritants to the gastro-intestinal canal, producing vomiting and diarrhœa, with symptoms of septic intoxication. They always cause irritation when aided by depressing conditions, such as heat and functional disturbance of any kind. After death it has been found that putrefaction always begins in the alimentary canal and extends to the rest of the body. The exact relation of bacteria to the changes of digestion, with our present knowledge, has never been definitely determined. We know their special action is upon the proteids or carbo-hydrates. The products of ordinary pancreatic digestion are the same, practically, as the putrefaction of albuminoid substances. As a source of contamination of the air, water and food, the soil stands pre-eminent, containing pyogenic bacteria, bacillus tuberculosis, bacillus typhosis and others, to say nothing of tetanus and malignant œdema, which are carried into the air by particles of dust. Bacteria penetrate the soil from three-fourths meter to one and one-half meters, each gramme of earth containing hundreds or thousands of them, depending upon the amount of organic matter.

For example, in Naples the dust in the most hygienic and least busy portion of the city has 1,000,000 to each gramme; in the dirty and busy thoroughfares a gramme contains from 1,000,000,000 to 5,000,000,000. A student more conversant with bacteriology than literature might easily misconstrue the expression, "See Naples and die."

The presence of bacteria, then, in air, water and food does not necessarily have any significance unless they are found to be pathogenic. The presence of pathogenic germs signifies the possibility and probability of disease, if transmitted to our bodies under conditions favorable to their development. Their relation to health depends on the character of the germs and the power of resistance of the tissues.

It is then of the greatest importance that we establish the best sanitary relations to prevent the multiplication of germs, and insist upon all measures conducive to well-being. In good health, a small number gaining admission into the body are destroyed or eliminated before their ptomaines can be generated and weaken the vitality of the individual. A most striking illustration of the prophylactic powers of healthy tissue is shown by the healing of wounds under the most adverse circumstances, while wounds in alcoholic and diabetic patients, and those following fever, often give us most trouble, even when treated in the most advanced and scientific manner.

Strict avoidance of all things that impair the normal tone of the tissues is the best possible preventive against infection by bacteria. Our boards of health should carry out more fully the rules of sanitation and disinfection.

The highest possible good to be derived from the scientific application of the laws of bacteriology is that which teaches us that sanitation, cleanliness and a strict observance of the laws of health is the best method to avoid disease.—The Southern Practitioner.

* Read before last meeting of the Middle Tennessee Medical Association.—From the Southern Practitioner.

THE TOXIC EFFECTS OF TOBACCO.

By GEO. W. CROCK, M.D., Vicksburg, Miss.

THE effects produced by the use or administration of tobacco in any of its forms are almost entirely due to the action of its active principle, nicotine.

The alkaloid receives its name from nicotiana, the botanical name of tobacco, so called in honor of Jean Nicot, a French diplomatist, who, in 1560, sent the seeds to France from Portugal as those of a highly medicinal plant.

It has been considered that tobacco smoke owed very little of its potency to nicotine and more to various combustion products; but as the effects of these vary only in degree from those produced by nicotine, being milder and less rapid in their toxic effects, the symptoms produced are usually considered as due to the nicotine present. As the result of a general acceptance of this idea, it has been the effort of some tobacco growers to cultivate the aromatic properties and diminish the nicotine.

The percentage of nicotine present in tobacco varies so largely, according to the different localities in which it is grown, and the methods of curing and analysis differ so materially in the results of their investigation, that it is impossible to give a definite statement of the percentage of the nicotine found in the prepared leaf. It varies from 2 to 8 per cent.

Adulterations.—Various adulterations are used in preparing tobacco in its different forms; but they, while not entirely inert by any means, play but a very small part in the toxic results of its use. Molasses, licorice, figs and glycerine are used to impart a sweet taste and to prevent rapid drying. Common salts and other salts are used for flavoring, and nitrate of potash or soda is sometimes added to increase the combustibility of tobacco used for the manufacture of cigars or for smoking tobacco. Anise and other aromatics are used for their flavor, and smoking tobaccos have their odor increased by the use of cascarilla bark and Tonqua bean, which is also used in scenting snuffs. These additions, except those for odor, are made in the form of a liquor in which the leaves are steeped. Lime is sometimes mixed with snuffs to increase their dryness, and these, of course, have an irritating effect on the mucous membrane of the nasal passages or gums, according to the method of its use.

Nicotine, $C_{10}H_{14}N_2$.—This alkaloid was first isolated by Posselt and Reimann in 1828, and is a colorless, transparent liquid having a strong tobacco odor, which is increased by the application of heat. It has a sharp burning taste, and is very soluble in water, alcohol, ether, turpentine and fatty oils.

Toxic Effects.—The symptoms of poisoning by tobacco are primarily nausea, vomiting and deathly pallor. The body becomes bathed in a clammy sweat, the surface is cold, respiration is quickened and occasionally followed by tetanus of the muscles of inspiration. The pupils are contracted, which is a curious fact in view of the well-known dilatation produced by belladonna, stramonium, hyoscyamus and

others of the Solanaceæ. The secretion of bile and saliva is increased, and there is a contraction of the entire intestinal tract. If the dose of nicotine be not sufficiently large to produce fatal result, secondary symptoms may appear months or even years after beginning the habitual use of the weed. These may be any of the following: granular inflammation of the fauces and pharynx; possibly from atrophy of the retina there will be loss or diminution of the power of sight, without any external appearance of the organ being affected; there may be various cardiac symptoms; the heart is dilated, and there is frequent pallor or a livid countenance; aberrations of the sense of sight with appearances of imaginary objects, a dry cardiac cough; pains as of angina pectoris are frequently present, shooting from the heart up to the shoulder and down the left arm or up into the neck; cold extremities, palpitations, feeble and irregular pulse, insomnia and diarrhœa alternating with constipation; facial neuralgia may exist, and the tongue will have habitually a thick whitish coating, and there may be marked irritation of the entire intestinal tract; chronic dyspepsia is frequently seen in tobacco users, caused by the waste of saliva which should be used in digestion.

Action.—Nicotine is very readily absorbed by the mucous and cutaneous surfaces, particularly if the continuity of either be broken. Its ready absorption is easily understood when it is known that fatal symptoms have developed from the mere inhalation of tobacco smoke, a condition in which but a small percentage of nicotine comes in actual contact with the mucous surface.

The primary action of the drug on the spinal cord is exciting, and, in fatal cases, death is due to a rapid paralysis of the respiratory center, without previous excitement, and never due to heart paralysis. Although the heart is markedly affected, the drug does not act on the cardiac muscular structure directly.

Large doses of nicotine cause convulsions, both tonic and clonic. The brain may be paralyzed, producing loss of consciousness or loss of voluntary movements after a more or less brief interval of excitement, followed by general paralysis, the spinal cord becoming insensible to irritation from affection of the gray matter of the anterior cornua.

Temperature.—The lowering of the superficial temperature is due to paralysis of the vaso-motor nerves.

Destruction.—It has not been definitely proved that nicotine is destroyed or diminished in any degree by the excretions, but it is supposed to be destroyed in part by the action of the kidneys and saliva.

Snuff.—Tobacco in this form is probably less productive of toxic effects than any other, whether inhaled into the nostrils or applied to the gums in "dipping," as small quantities are used in either case, and there is very little nicotine absorbed. Its use in this form causes redness and some swelling of the mucous membrane, and will, after continued use, result in a hypertrophy of the membrane, particularly if used in the nasal passages, and a consequent loss of activity of the olfactory sense.

Cigars and Pipes.—It is the use of cigars and plug tobacco, either for chewing or smoking, or the use of granulated tobacco in pipes, that produces the most toxic symptoms. In these cases the effect is produced by the absorption of the tobacco in solution, or the nicotine is absorbed from the smoke.

In cigars, the effect comes not only from the partial inhalation of smoke, but also from tobacco in solution, as the tip of the cigar is moistened by the saliva, and lies in contact with the mucous membrane of the mouth during smoking.

Cigarettes.—The use of these has been condemned as not only the most injurious form in which tobacco can be used, but by some is considered a vice parallel to the use of opium or cocaine. Now, while this is certainly an extreme view, there is no doubt that their habitual use occasionally leads to disastrous results.

In the use of cigarettes the effects are produced by the complete inhalation of the smoke, and in their use the adulterants have more effect than in any of the other forms of tobacco.

In the cheaper grades of cigarettes the lack of natural quality in the tobacco is made up by the use of the various adulterants mentioned; and where the indulgence is excessive, particularly in the growing young, the effects are most marked.

Some effect is produced, too, from the inhalation of the burning paper, particularly if poisonous bleaching agents have been used in its manufacture.

Toxic Dose.—This varies from the small amount absorbed by the individual who smokes his first cigar or takes his first chew to the quantities that have been taken with suicidal intent or administered for therapeutic or criminal purposes. There are very few cases of poisoning by the pure alkaloid. One is interesting, as it is the first instance in which a pure alkaloid was used for criminal purposes. This was the poisoning of M. Fougines by Count Bocarmé and his wife. Another case is on record in which an individual took it for the purpose of suicide. The quantity used in either of these cases is unknown. The amount of nicotine necessary to produce the primary symptoms of poisoning in an individual using tobacco for the first time is, of course, small, and the degree of tolerance acquired by habitual users of the weed will vary according to the length of time they have been addicted to its use, the percentage of nicotine present in the particular brand of tobacco used, and the form in which they use it.

It is apparent that a chewer can acquire a greater degree of tolerance to nicotine than a smoker, as it is so much more readily absorbed when in solution with the saliva, and enters the system in greater quantities. In a smoker the effects are produced by the mere contact of the tobacco smoke with the mucous membrane by inhalation, which is partial when the smoke is only drawn into the mouth, and complete when drawn into the lungs, excepting in the case of the cigar smoker, where some of the tobacco is in solution from the contact of the cigar with the tongue and saliva. Nicotine is one of the most violent poisons known to chemistry, and in doses sufficiently large to act fatally, its action is very similar to that of hydrocyanic acid. On the lower mammalia its action is just as rapid and as surely fatal as prussic acid, and almost equally so in man.

The fatal results that have come from smoking tobacco are probably due to the inhalation of the smoke and its consequent direct contact with the moist mucous lining of the lungs, by which the nicotine is readily absorbed. Death has followed the administration of a decoction of tobacco leaves in enema, either for therapeutic or criminal purposes, and also from its use as local application to the skin, thus showing that its application in solution is favorable to very rapid absorption.

The effect of nicotine is practically the same as that of tobacco in solution, merely differing in degree.

Dose.—Tobacco infusion has been administered in enema in doses of from ℥ss to ℥ ij, but toxic symptoms have resulted from much less than this maximum. In many instances a dose of ℥ j would be sufficient to produce marked toxic symptoms. By the mouth five or six grains of tobacco are emetic, and anything more will be likely to prove toxic. The alkaloid is so rarely used in therapeutics that it is impossible to tell just what a fatal dose would be, but one-tenth of a grain or over would probably produce very severe symptoms.

Post-mortem Appearances.—None are known which can be directly attributed to nicotine or tobacco alone.

The signs of death from the action of the poison on the lungs have usually been observed. If tobacco has been swallowed in sufficient quantities to act fatally, there will exist some redness of the stomach and intestine. An analysis of the contents of the stomach would detect the presence of the alkaloid where it had been swallowed.

Antidote.—Strychnia, $\frac{1}{12}$ grain of the nitrate subcutaneously, or from 10 to 15 minims of tincture of nux vomica by the mouth.—Hahnemannian Monthly.

A NEW FLUORESCENT SUBSTANCE.

By LÉON BERTRAND, M.D., Antwerp, Surgeon Steamship Southwark, Red Star Line.

I BEG to introduce to notice a new fluorescent chemical discovered by Dr. Edm. Van Melckebeke, of Antwerp, which is called double fluoride of uranyl and ammonium. I had the honor two weeks ago, at a meeting of the Société Medico-Chirurgicale of Antwerp, of demonstrating Edison's fluoroscope, which was very highly appreciated, indeed; but I have to confess impartially that it is equaled in every respect by Dr. Van Melckebeke's discovery, which I had the pleasure to experiment with myself. Moreover, this last has the advantage of being very cheap.

The following is the manner in which Dr. Van Melckebeke discovered his new chemical: First, recalling the fluorescent properties of the nitrate of uranium, he made a solution of that substance, and coated a piece of cardboard with it; but no fluorescence was obtained under the X rays. He then modified the method of impregnating the cardboard, and, instead of coating it with the solution, he fixed the nitrate of uranium on the cardboard through the medium of a gummy solution. The screen then became fluorescent under the X rays.

Dr. Van Melckebeke explains the failure of the first method to produce fluorescence by the fact that the solution impregnated the fiber of the cardboard, and after evaporation of the water the salt remained either in an amorphous state or in a state of confused crystallization. Fluorescence, like rotatory polarization, seems to require a state of perfect crystallization.

Among the chemicals which precipitate in a state of perfect crystallization are the double fluorides. Wurtz's Dictionary (vol. iii, p. 561) mentions a double fluoride of uranyl and ammonium with the formula: $Ur_2O_4Fl_3$, NH_4Fl.

If one drop of nitrate of uranium and a particle of fluoride of ammonium are brought together, they will produce regular octahedrons. But if larger quantities are used, five hundred and four parts of nitrate of uranium and one hundred and eleven parts of fluoride of ammonium, according to the formula of Wurtz and the equation:

$$2\,(UrONO_3 + 3\,H_2O) + 3\,NH_4Fl$$
$$[504] \qquad [111]$$
$$= Ur_2O_4Fl_3,\ NH_4Fl + 2\,NH_4NO_3 + 6\,H_2O,$$

no crystals are produced.

Dr. Van Melckebeke increased gradually the quantity of fluoride of ammonium in the proportion of about one part of fluoride of ammonium to two parts of nitrate of uranium. He obtained a crystalline deposit, which, examined under the microscope, presented all the characteristics required. After precipitation, the liquid had lost its color entirely.

In order to obtain this result, the proportions to be used seem to correspond approximately to the formula: $Ur_2O_4Fl_3$, 4 NH_4Fl, according to the equation:

$$2\,(UrONO_3 + 3\,H_2O) + 6\,NH_4Fl$$
$$= Ur_2O_4Fl_3,\ 4\,NH_4Fl + 2\,NH_4NO_3 + 6\,H_2O.$$

The deposit is put in a filter, is washed with cold water, and dried. It then appears as microscopic octahedral crystals, yellowish green by reflection, and colorless in thin coats by transmission; it becomes fluorescent while exposed to the violet rays. These crystals are not very soluble in cold water, but are more soluble in boiling water; hence they may be deposited on the surface of objects by simple cooling of a hot saturated solution.

As far as we know, the chemical is a new one. It is certainly different from the one mentioned by Wurtz, as much by its composition as by its crystallographical properties and by its smaller degree of solubility in water. It has some analogy to the double fluoride of uranyl and potassium, $Ur_2O_4Fl_3$, 4 KFl, and to the double fluoride of uranyl and sodium, $Ur_2O_4Fl_3$, 4 NaFl (see Wurtz's Dictionary Supplement, vol. ii, p. 1628).

Oxyfluoride of uranium and ammonium can be spread on pieces of cardboard through the medium of different excipients, such as a solution of gelatine, oily varnishes, etc. This is the best way to proceed: On the bottom of a basin put a sheet of strong blotting paper and cover it with a boiling saturated solution of the oxyfluoride; let it cool, and when the paper is covered with a crystalline coating decant the liquid. Repeat the operation two or three times. In order to give some solidity to the deposit, cover it with a coat of gelatine. The fluorescent power of the chemical prepared in this way seems to vary according to the thickness of the coat of gelatine.

Dr. Henri Van Heurck, of Antwerp, has a good method of photographing the image thrown on these screens. He puts the screens in close contact with the film, and obtains a very good picture in a few moments.

Dr. Van Melckebeke's discovery dates from the beginning of March. The net cost of the double fluoride of uranyl and ammonium is, in Europe, twenty-seven cents an ounce.—Medical Record.

VANADIUM AND SOME OF ITS USES.

By JOHN M. TOBIN.

THE chief source of vanadium is vanadate of lead, which is usually found associated with magnetic iron, gold and silver. Vanadium is found in various places throughout the United States—Phœnix, Ariz.; Lincoln, Neb.; Texas, Mexico and Connecticut; the percentage varying from five to twenty, according to concentration of ore.

Its chief use is in the manufacture of ammonium vanadate, which is used entirely in the arts, in dyeing, ink making and photography. It has not been used to any extent in medicine, but lately it has been used as a test for the alkaloids.

Manufacture of Ammonium Vanadate.—The concentrated ore is fused with nitrate of potassium and dried carbonate of sodium in black lead crucibles. After cooling it is ground very fine, washed with boiling or hot water several times, solution concentrated, and saturated with ammonium chloride (free from iron), which precipitates ammonium vanadate in very fine powder. Filter and dry at room temperature. Wood and iron vessels must be avoided, as both discolor the salt; the former from acid tannic, the latter from the iron.

Further purification may be effected by repeated fusings with nitrate of potassium and sodium carbonate, etc., as above, and again precipitating with ammonium chloride.

The following formula produces a very satisfactory photographic developer:

Vanadium pentoxide	1 drachm
Sulphuric acid	2 "
Water	2 ounces

Add metallic zinc in excess; after effervescing has ceased, and solution is lavender colored, filter quickly and cork tightly. One drachm of the above solution to one pint of water makes a very good developer, and is intensified by dilute acetic acid.

The concentrated solution does not keep well, but can be quickly restored to activity by adding sulphuric acid and metallic zinc in excess, until lavender colored, as originally.

In attempting to make vanadium bronze from copper sulphate, ammonium chloride and vanadate, I added sulphuric acid and metallic zinc, and allowed the solution to remain over night in a pitcher, which latter I found the following morning coated with a deposit of brilliant metallic copper, resembling highly burnished copper. I have repeatedly tried to duplicate the experiment, but have not been able to do so.—Pharmaceutical Era.

COPPER FROM GREEN WATER.

ONE of the most interesting sights in the great mining town of Butte, says the Anaconda (Montana) Recorder, is the process by which copper is caught from the emerald-colored water that flows from the Anaconda and St. Lawrence mines. It is estimated that this water, which for four or five years went to waste, is now bringing the Anaconda Company $30,000 a month, at a cost of about $1,000 a month.

It is only within the present year that the company undertook to handle this water. Heretofore it was worked under lease. An old German named Mueller was the first man to save copper from the water.

During the last three years Thomas Ledford had a lease on the water. He paid a twenty-five per cent. royalty to the company. It is claimed that he realized at least $100,000 a year from the water. Ledford is a pretty rich man to-day. Now that the company is operating the waters on its own account, it has discovered what a great money making enterprise it is.

At the present time several acres of ground are covered with wooden vats. These are filled with all the old scrap iron they can hold. It has proved a splendid scheme for disposing of the tons and tons of old iron the company has accumulated for years. Old hoisting cages, water pipe, wheelbarrows, railroad iron, in fact any old thing that consists of tin or iron, is appropriated to this service.

It is said, for every pound of iron put into a vat, a pound of copper is produced. Where the water first attacks the iron, the copper absorbs the iron completely within three weeks. After the precipitation is effected the water is drawn off and the slimy copper is transferred to another tank where the water is further drained off. These latter vats hold about fifteen tons of the copper, which now has the appearance of a clayish substance. This is sacked into packages of about one hundred pounds. When in this shape it is sent to the smelters. The product carries an average of eighty-six per cent. pure copper. The iron remaining in it makes a fine flux, and when mixed with other smelting ore, it is said to bring the ore up to a value of about $300 a ton.

The water from the mines is the most profitable product of the Anaconda Copper Mining Company.

CRYPTOSCOPE SCREENS.

IN L'Elettricità there is given an account of a note presented by Prof. E. Salvioni to the Accademia Medico-Chirurgica of Perugia on the subject of the comparative value of various salts for the purpose of fluorescent screens for Roentgen ray work. The method of comparison adopted consisted essentially in varying the density of the radiation received by changing the angular direction of the screens, i. e., making the rays fall at a more or less oblique angle on the screen. When the two screens give an apparently equal illumination, the relative efficiency of the fluorescent salt is immediately determined by the angle between the screen and the direction of the ray. (This looks open to several errors, but it is stated that experience shows it to be

reliable.) The results are given for various substances to four significant figures, a degree of precision which is obviously altogether out of the question in photometric work of this kind. In fact, different samples of barium platino cyanide differ by 40 per cent. Potassium platino cyanide would appear to be about half as effective as the barium salt weight for weight, and sodium and calcium platino cyanides less than a quarter. The power of tungstate of calcium and ammonium-uranyl fluoride comes out as about a twentieth of the best sample of barium platino cyanide. The American suggestion of oxide of zinc was not tried, says the English Electrical Engineer. Probably very different results would be obtained with a different tube and voltage, and experiments in this direction and also as to the differential absorption of different screens are promised.

FISKE'S HELM INDICATOR AND STEERING TELEGRAPH.

To erect engine room telegraphs, steering telegraphs, and the like, on board ship, is very often a most difficult operation. It is always considered necessary that connection between the transmitter and the receiver shall be positive, that it shall be made by shafts and wheels. To find a fair lead for these is often almost impossible, owing to the presence of pipes and machinery in the direct line they should naturally follow, and hence indirect courses have to be adopted. Many attempts have been made to use electricity as the medium of transmission, but generally they have not inspired confidence. Lately, however, Lieutenant B. A. Fiske, of the United States Navy, has devised a series of electrical instruments for use on shipboard, and has attained very great success with them in an extended series of trials in the war vessels of his own country. Among these are a helm indicator and a steering telegraph, both of which were described by him in a paper on "Electricity in Naval Life," read by him before the United States Naval Institute. These two instruments we now propose to describe by aid of the engravings on this page.

The helm indicator is illustrated in Figs. 1 to 6, its object being to show on dials placed in various parts of the ship the exact position of the helm at all times. The principle of action is shown in Fig. 1, and is quite simple. A sliding contact, connected to the rudder post, moves over a wire like the wire of a "meter bridge," connected to a source of electric energy, such as a primary or secondary battery or a dynamo. In the figure this wire, a b, is shown coupled to the electric light leads of the ship, with a resistance interposed to bring the current down to two amperes. The middle of the resistance wire, c, is coupled to a main running through the ship, while the moving contact, d, is coupled to a second main. Joined in parallel to these two mains are the various receiving dials as shown. It will be quite evident that the difference of potential between the two mains, e and f, will depend on the position of the sliding contact, d. In the position shown, a current will circulate as indicated by the arrows. As the rudder gradually moves toward the middle position the distance between d and e diminishes, and consequently the difference of potential between e and f grows less. When d touches e, both mains are at the same potential, and there is no electric pressure to move the pointers of the indicators (Figs. 1 and 6) from the zero position. When the helm is put over the other way and the contact, d, goes to the right of e, the current in e and f is reversed, and the indicators move over to the other side. Assuming that there is a constant difference of potential between a and b, there will be a certain definite current flowing through each indicator for every position of the contact, d, and for every degree of helm either way the indices will point to a corresponding spot on the scale.

The resistance wire ordinarily used is the same as that employed in the Fiske range finder, an alloy of 70 parts of copper with 30 parts of nickel. It is No. 22 gage, and has a resistance of about ½ ohm per foot. It is laid in an arc, of which the center is the rudder post and the radius usually about 22 inches.

The method of carrying the resistance wire is shown in Figs. 2 to 5. The wire, a b, is laid in a groove in an arc of wood (Fig. 2), and over it there moves a slider, d (Figs. 3, 4 and 5). The arc of wood is placed on a curved base plate of metal, and is covered with a similar piece of metal. The main, f, is joined to the center terminal in Fig. 2, and thence to the central point, c; the main, e, is coupled to the slider (Figs. 3 and 5). To the rudder post is fixed an arm (Fig. 5) which carries a shoe sliding on the upper cover as shown in Fig. 5. On the underside of this shoe is a finger carrying the insulated contact, d, which presses on the wire in the groove.

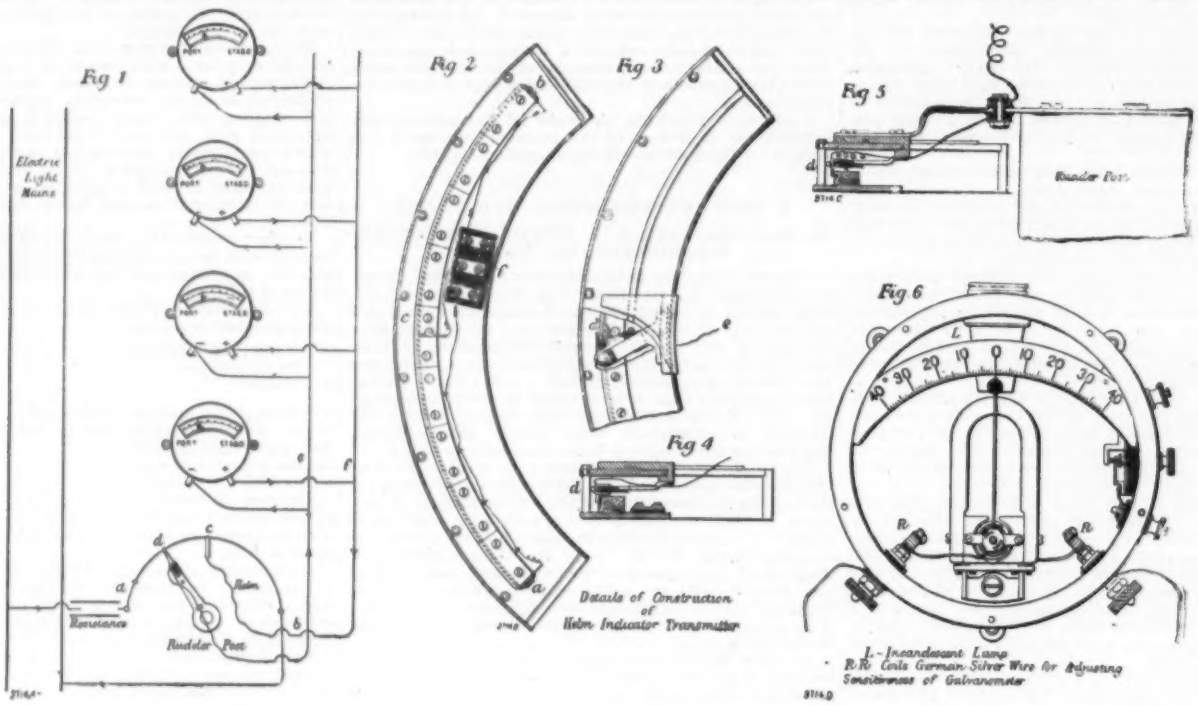
Fig. 6 shows the galvanometer which is used as an indicator, and which is similar to that used in the Fiske range finder. The current passes through a light coil of wire in the form of a bobbin pivoted between the poles of a permanent magnet. This coil is normally held in a position of rest with its index in the middle of the scale by two spiral or volute springs, one at each end of the axis. When a current passes through the coil it tends to turn the coil in one direction dependent on the direction of current, until it takes a position in which the force of the springs just balances the magnetic force between the magnet and the current. The galvanometer is inclosed in a massive cast iron case, and is securely sealed against the entrance of sea water; its resistance is about 60 ohms. R R are two German silver resistances, by which its sensitiveness can be adjusted. L is an incandescent lamp by which the dial is illuminated from behind, the lamp terminals being shown at the side with a resistance between them to reduce the voltage to suit the lamp.

The helm indicator was given a year's test in service on board the armored cruiser New York. It has since been installed on board the battleships Indiana and Massachusetts, with five indicators in each ship, and has passed the year's test successfully. It is now being installed in the Texas and is to be installed in the Brooklyn.

It would have been more in order to have described the steering telegraph before the helm indicator, since the order must precede the response. Both operate on the same principle, but the mechanism of the helm indicator is rather the more simple of the two, and hence it was fitting to deal with it first. The steering telegraph enables the officer of the watch to move a finger over a dial in front of the quartermaster, just as the present mechanical telegraphs do, but it further enables several such dials to be used and placed, not only at the steering positions above and below the protective deck, but also in the conning tower and the captain's cabin, if desired. Fig. 7 illustrates the principle of the apparatus. A resistance wire, a b, has a current of two amperes constantly flowing through it in consequence of being coupled to the electric light mains through a resistance. The wire, a b, can be joined at two points to the indicator mains at the right of the figure. One of these points, e, is fixed, and the other, d, is movable. When these two are far apart there is a large difference of potential between the mains, and as d approaches e this difference decreases until it becomes zero, just as described in relation to the helm indicator.

Three transmitters are shown in the engraving, but naturally only one must be used at a time, and to insure this the apparatus is so constructed that the contact, d, breaks contact with the wire when it comes opposite e. Fig. 8 shows the apparatus somewhat diagrammatically. The resistance wire is wound in a spiral groove on the circumference of a cylinder of insulating material; the two ends of the wire are connected to flat springs, g, h, coupled to the binding post. The permanent contact, c, is connected by a short pin to a metal ring placed at one end of the cylinder and running in contact with the spring, h. At the point where the permanent contact, c, is connected to the wire, the groove in the cylinder is cut down deep into the cylinder, so that the contact, d, cannot touch it. The contact, d, is mounted on a nut working on a screw moved by a handwheel, which is also geared to the cylinder. As this wheel is turned, the cylinder, with the resistance wire, is rotated, and the contact moved along it.

Beside each transmitter is a receiver, so that the officer can see the effect of his signal. He turns his handle until the receiver in front of him points to the angle of helm desired, and he then knows that the same indication is given to the quartermaster. The



THE FISKE HELM INDICATOR AND STEERING TELEGRAPH.

receivers are practically the same as those already described.

The steering telegraph was given a year's test in sea service on board the United States ship New York, and the test having been passed successfully, the apparatus has since been installed in the United States battleships Indiana and Massachusetts. It is now being installed in the Texas and is to be installed in the Brooklyn. The above particulars and cut appear in a recent issue of London Engineering.

THE TEMPERATURE OF INCANDESCENT LAMP FILAMENTS.

REFERENCE in a recent number of the Electrical World was made to a method of measuring the temperature of incandescent lamp filaments as employed by M. Janet. In a communication to the Académie des Sciences and published in Comptes Rendus, M. Janet gives more explicit details of the method employed. The method is based upon the experimental results of M. Violle, who has determined the mean specific heat of carbon between zero degrees and 1,000 degrees C. If E be the applied potential difference at the lamp terminals, by varying E both the resistance and temperature will vary. A curve may be plotted by using the resistance R as abscissæ and E^2/R as ordinates where E^2/R is the loss in radiation at any temperature θ. By employing a lamp under normal conditions and interrupting the current at a specified time, the variation of the resistance of the filament may be observed as the filament cools. A second curve having the time as abscissæ and the resistance as ordinates may be plotted. A third curve may be derived from the first by using the time as abscissæ and the loss due to radiation at each instant as ordinates, the area of which curve will give the total loss due to radiation through the range of temperature employed, and by dividing by the mechanical equivalent of heat, the corresponding quantity of heat may be obtained. Assuming the filament to be of pure carbon, it is weighed and M. Violle's formula applied. M. Violle found that (a) above 1,000 degrees C. the mean specific heat of graphite may be expressed thus: $C_0^t = 0{\cdot}355 + 0{\cdot}00006 \times t$, where t is the time. (b) The heat given off by one gramme of graphite, between the temperature of volatilization and zero degrees Centigrade, is 2,050 calories. Therefore the boiling point of carbon is 3,600 degrees C.

ELECTRIC LIGHTING OF AVENUE DE L'OPERA, PARIS.

SINCE the 23d of November, Avenue de l'Opera, one of the finest thoroughfares of Paris, has been lighted by electricity, and the results obtained are certainly, from every point of view, most satisfactory. In the few lines that follow we shall give various data as to the principal arrangements adopted.

In order to supply the arc lamps of Avenue de l'Opera, a branch circuit was taken from the line already established in Rue Petits-Champs and in the avenue. It comes from the municipal works of the Halles. The primary line of 2,400 volts supplied by Ferranti accumulators enters a kiosk installed to the left, at the corner of Avenue de l'Opera and Rue Petits-Champs. The wires of the branch first traverse high tension bipolar interrupters, NN, and fusible circuit breakers, AA, insulated in petroleum and placed in porcelain receptacles. These apparatus are placed upon a slab of white marble that may be seen in the center in Fig. 2, which shows the installation of the transformers and the distributing apparatus in the kiosk. Each of these two circuits is connected with a 15 kilowatt Labour transformer constructed by the Société d'Eclairage Electrique, and designed to supply 25 arc lamps of a model that we shall describe further along. The transformers are placed at the upper part of the kiosk. The primary circuits have an e. m. f. of 2,400 volts, and the secondary ones of 220 volts. At their exit from the transformers the secondary circuits supply the lamp circuits, which all end in the kiosk, each at a separate board. The cables, which are concentric, of 0·006 square inch section, and covered with lead, are placed directly in the ground at a depth of 24 inches, with a metallic grating to indicate their presence. The concentric cable permits of preventing the effects of induction upon the iron armature and upon the different neighboring cables.

The arc lamps are mounted by fives in tension. Special branches have been formed through the aid of junction boxes at the foot of each lamp post. It is in these boxes that the junctions of the annular cable are made. At the exit the concentric core of the cable is connected with a bipolar commutator of two directions that permits of making the current pass into the lamp or into an equivalent resistance.

The lamps, which are 50 in number, are distributed in 10 circuits, 5 of which are permanent and 5 variable. The two transformers mentioned above are each designed to do duty for 5 circuits. It is possible, at will, to couple either the permanent or the variable circuits upon the same transformer through the maneuver of special commutators.

The distributing boards designed for each circuit of 5 lamps are likewise placed in the kiosk to the right

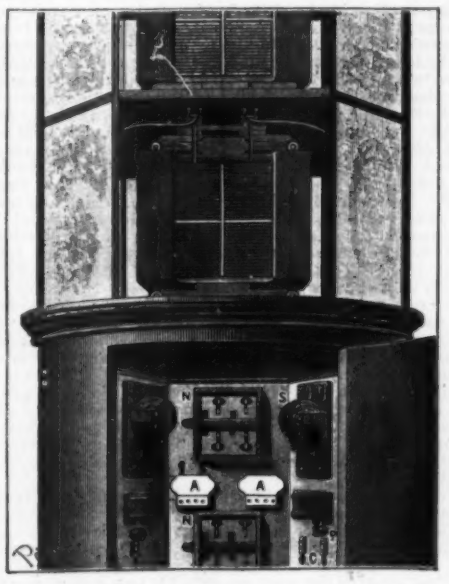


FIG. 2.—INTERNAL VIEW OF THE KIOSK CONTAINING THE TRANSFORMERS.

and left of the board at which ends the line coming from the works. Each board includes two circuit breakers, C, a plug, P, for interposing an amperemeter, a self-induction coil, S, and a grounding apparatus of the Cardew type.

The lamps used are the Kremenezky differential ones, with fixed luminous point, of 14 amperes, operating by five in tension upon 220 volts. These lamps were selected after a competition at the Halles works between the various models of lamps for alternating currents.

The effective electromotive force at the terminals of each lamp is 36 volts. A loss of 20 volts is reckoned in the self-induction coil for assuring a certain elasticity of regulation.

The lamps are placed upon posts 16 feet in height and 43 in number at the right and left of the avenue, and 7 in number in the center of the thoroughfare. An internal reflector is fixed in the globe so as to send all the light to the ground. The distance between the posts is about 98 feet. Fig. 1 gives a general view of the installation of the posts and shows the arrangement adopted. The view was taken from Theatre Français Place.

The installation here described, which gives life to the avenue and modifies its aspect at night, was made by the municipal service of electricity of the Halles under the direction of M. H. Marechaie, engineer of the first section. The lighting is brilliant and shows three sharply defined lines of fire.—La Nature.

FIG. 1.—GENERAL VIEW OF AVENUE DE L'OPERA (PARIS) LIGHTED BY ELECTRICITY.

SCENERY OF THE MOON.

By Sir ROBERT BALL, Lowndes Professor of Astronomy, University of Cambridge, in the N. Y. Sun.

NOTWITHSTANDING that the moon is 240,000 miles distant from the earth, it would in some respects be hardly an exaggeration to assert that we are better acquainted with the topography of our satellite than we are with that of the globe which forms our home. No doubt it may at once be admitted that with respect to a large portion of the moon, dwellers on the earth are necessarily in total ignorance. It is a peculiarity of our satellite that it manages its movements in such a manner as to withhold nearly half of its surface from ever being inspected. It follows that we have no means of learning what is on the other side of the moon. I do not suppose, however, that in these days any one believes that if we could see it we would find any characteristic difference between the scenery on the remote side of the moon and on the side which is turned toward the earth. So far, however, as the neighboring globe is displayed for our observation, we can certainly assert that there is hardly a spot possessing the size of an ordinary parish which has not been studied and photographed, sketched by competent draughtsmen, duly laid down on elaborate charts of the lunar surface, and in many cases received the dignity of a special name.

The circumstances of the moon's situation render it much easier for us to survey its scenery than it is to survey the scenery of any other celestial body. For in the first place, the moon may be regarded as quite close to the earth, in comparison with the distances by which we are separated from the other heavenly objects. The sun is nearly four hundred times as far away as the moon; and that planetary globe whose surface we have studied to the greatest advantage—I mean, of course, Mars—is, even under the most favorable conditions, still at a distance from the earth which is not less than one hundred and forty times as great as that of the moon. But besides its comparative proximity, there is another circumstance which renders it comparatively easy for us to study the features on our satellite. If a globe like the earth in size, as well as in other particulars, had been situated at the same distance from us as that at which the moon now revolves, it seems quite possible that we should never have been able to obtain any clear notion as to the geography of such a globe. For our earth is, of course, surrounded by a thick coat of atmosphere: this atmosphere is at all times, and in all parts, more or less opaque from the presence of large quantities of floating material, while there are always some regions where there is temporarily complete obstruction from the presence of clouds. The atmosphere would thus oppose great difficulties to the study of the geography of our earth by an outside observer. It may, indeed, be well doubted whether even the outlines of the continents could be completely discerned, notwithstanding that the area of the earth at the distance of the moon would be thirteen times larger than that of the moon as presented to us.

For the purpose of the terrestrial astronomer, it fortunately happens that the moon is almost entirely destitute of atmosphere. The features of its surface are consequently never obscured by any of those causes which would tend to hide the features of the earth from outside scrutiny. Whenever the clouds on our globe are out of the way, it is then possible to observe the moon with but little obstruction. If we also remember that many of the features of our satellite are within reach of a telescope of comparatively moderate power, it will not be surprising that the lunar scenery has attracted so much attention and that thousands of minute features on its surface have been carefully identified. In some cases, accomplished observers have devoted themselves with praiseworthy assiduity to the detailed examination of special parts on the surface.

It would be impossible to enumerate all the astronomers of recent times whose labors have been directed to the study of the lunar scenery. I may, however, here mention a few names, adding the remark that there are doubtless many others whose valuable labors could not be overlooked if it had been possible to give a more complete account of the subject than would be practicable within the limit of the present article.

First, I must mention Mr. Nasmyth, who was at once a famous mechanical engineer, a skillful artist, and a devoted student of the stars. He employed his well earned leisure in the study of celestial objects, and he devoted especial attention to the moon. The work which he produced in conjunction with Mr. Carpenter is a standard authority on the lunar scenery, and is perhaps one of the most beautifully illustrated books that has ever been devoted to the subject of the heavens. I must also refer to Prof. Holden and other distinguished astronomers at the Lick Observatory, on the top of Mount Hamilton, in California. They have applied their resources to the photography of the moon with remarkable success, and some of their pictures of our satellite have formed the basis upon which Dr. Weinek has produced exquisite drawings of the lunar features.

As, perhaps, the latest book on the topography of the moon, I may mention the elaborate work by Thomas Gwyn Elger, who is himself one of the most assidnous of lunar observers. He has collected together the most interesting facts relative to the topography of our satellite. I am much indebted to the various authorities I have named for information which I am utilizing in the present paper.

When we look up at the full moon, even without calling the telescope to our aid, we at once notice the presence of a number of large dark patches. It is certainly true that there are no sheets of water nor anything like water at present visible on the moon, even with the highest power of our telescope. In fact, there are sound physical reasons why it does not seem the least likely that there could be any water in the fluid form present in our satellite. At the same time the appearance of these dark spots, in days before telescopes were employed, suggested that those objects were basins of water, and accordingly they were anciently called "seas." In modern days, astronomers have somewhat awkwardly retained this name, or its Latin equivalent, to designate these peculiar dark tracts, notwithstanding the absence of water. Many of these are of enormous extent, so-called seas, to be reckoned in thousands of square miles. In fact, nearly half the visible surface of the moon is so occupied. It

is still an open question as to whether these regions have ever been covered with water. No doubt it seems the simplest supposition, so far as certain phenomena are concerned, to believe that they are the basins in which great seas did once roll, but that as the moon has gradually cooled down from a primeval state in which it was largely composed of molten matter, the water from the seas penetrated into the interior, and there entered into chemical union with the materials which were crystallizing. It certainly does seem that whole oceans full of water could have been thus disposed of. There are, however, many who believe that these dark regions are due to the pouring forth from the interior of vast volumes of molten lava which spreads over deep hollows, burying more or less completely the objects which had previously occupied them. In some places indications are found that these regions were once occupied by other structures of which only vestiges are any longer to be discerned.

There can be no doubt that these so-called seas lie lower than the general surface of the moon. If water was to be poured on our satellite, it would certainly tend to fill the basins once again. Close examination of these remarkable tracts shows that the grayish, slaty tint that they usually present is by no means uniform. As Mr. Elger remarks: "I have frequently seen the surfaces in many places covered with minute glittering points of light, shining with a silvery luster, intermingled with darker spots and a network of streaks, far too delicate and ethereal to represent in a drawing." In certain places in the lunar "seas" regions of a yellowish or greenish tint have been occasionally noticed when the illumination was under suitable conditions. Such tints have sometimes been attributed to the possible presence of some form of vegetation, though this would hardly be compatible with the absence of a lunar atmosphere.

The grandest illustration of this class of objects is the great Oceanus Procellarum, which covers an area not very different from that occupied by European Russia. If, however, we desire to look at one of the objects of this class which seems most emphatically to suggest its origin to have been an ancient sea basin, I would specially call attention to the Mare Crisium. It needs but little effort of the imagination to fill this remarkable gulf with water, and then to see how its margin forms the cliffs against which the waves have hurled themselves for centuries. Close examination reveals that the floors of these "seas" are marked over with various irregularities, so that when such features are spoken of as smooth, it must be understood that this is merely by way of contrast to the extreme ruggedness which prevails over the greater part of the lunar surface.

The most characteristic features of the scenery of our satellite are, however, the remarkable objects which are the results of volcanic phenomena. There are many classes into which these objects can be divided, but for our present purpose it will, perhaps, be sufficient if we attempt to give some brief account of what may be called the walled plains, and of the volcanic craters properly so termed. According to Mr. Elger, the most perfect example of a walled plain on the moon is the great object known as Ptolemæus. The remarkable district so designated covers an area on our satellite considerably larger than Wales. It is situated nearly centrally on that face of the moon directed toward us, so that it generally lies very conveniently placed for examination. It will be recognized as the last of a chain of four magnificent objects of the same character, which lie along the coast of that darkest of lunar seas, known as the Mare Nubium. Ptolemæus may be described as almost circular in outline, though sometimes it might be regarded as a rudely six-sided figure. Its appearance may be compared to that of an eyeglass, whereof the little handle is formed by a beautifully shaped crater bearing the name of Herschel. The floor of Ptolemæus is a plain, not much depressed below the general level of the lunar surface. It is so vast that an observer placed in its midst would see a boundless horizon stretching away from him on all sides. He would not realize the fact that Ptolemæus was surrounded more or less completely by a noble circle of lofty mountains, for these mountains would be below his horizon. Some of the peaks ascend one mile, and, in certain cases, even two miles above the interior of the plain. At certain points the mountain chains will be found interrupted by mighty passes. Especially is this the case on the margin between Ptolemæus and the next adjoining walled plain, which is called Alphonsus.

To my mind, however, the most interesting of these objects, as well as perhaps the most perfect representative of its class, is the beautiful walled plain named Plato. This is so well placed, and has such a striking appearance, that it is probably one of the first objects which a student of lunar topography succeeds in identifying. No other object of the same character happens to lie in its neighborhood, and, consequently, there is but little difficulty in distinguishing the walled plain referred to; for it may be remarked that the aspect of the moon changes so frequently that the identification of some features is at times a little troublesome. This partly arises from the never ending varieties of light and shade as the moon changes from day to day.

There is also another circumstance which is sometimes apt to puzzle the beginner, for, owing to what is called the moon's libration, the face which is directed toward us is not always exactly the same. Hence it follows that at different times the distances of objects from the circular edge of the moon to which they are lying nearest will be found to vary. The difficulties will, however, not prevent the student from readily identifying the superb object known as Plato. It lies in the northern region of the moon, and as our telescopes exhibit the object inverted, this means that Plato must be sought at the lower part of the field.

This walled plain is situated on the coast line of a magnificent lunar sea, namely, the Mare Imbrium, which may, perhaps, be described as a stupendous gulf branching off from the Oceanus Procellarum. This is, indeed, the region of the moon toward which we would specially direct the attention of the student. There he will find magnificent examples of the most striking types of lunar scenery. The floor of Plato measures about sixty miles across. It may be said to be flat, with the exception of certain small irregularities; but the fact which chiefly strikes the attention of the observer, and which is specially noticeable in the photographs, is the unusual darkness of that floor as compared with other parts of the moon. The rampart of mountains which surrounds Plato is comparatively perfect, and no more pleasing lunar picture can be beheld than when the shadows of these mountain peaks lie stretched along the dark central floor, as they do when the sun is in such a position that it would just appear to be rising to a lunar inhabitant who was stationed in the neighborhood.

I may mention that the shadows of lunar mountain peaks not only greatly enhance the beauty of our lunar picture from a spectacular point of view, but they have another importance. They present to the astronomer the only means which he possesses for measuring the altitudes of the lunar mountains. For, as a lunar mountain is more or less pointed toward the observer, its elevation above the surface cannot be attained by direct measurements.

We may illustrate the process employed in the determination of the altitude of a lunar mountain by the operation of calculating the height of a flagstaff from knowing the length of the shadow which it casts at noon. If the length of that shadow be measured on certain days, which will, of course, vary with the latitude of the observer, then the length of the noontide shadow of the flagstaff would not be different from the height of the flagstaff itself. If the observations be made on any other days save those which have just been mentioned, then the length of the noontide shadow would be greater or less than the altitude of the flagstaff. However, by a little calculation, which any one who has learned mathematics can easily understand, it is possible from knowing the length of the shadow and the true altitude of the sun at noon on the day in question, to determine the height of the flagstaff by which that shadow has been cast.

We can measure the lengths of the shadows which are cast by the mountain peaks on the surface of the moon. Suppose, for instance, the shadows were observed to extend half way across the floor of Plato; in such a case we know that the length of the shadow would be about thirty miles. From our knowledge of the relative positions of the earth and the moon we can determine the height of the sun as it would have appeared to a lunar observer. These facts suffice to enable us to ascertain the altitude of the corresponding peaks.

The isthmus on which Plato is situated contains many other interesting objects. In fact, the student could have no better study than to familiarize himself with the characteristics of the several objects around the Mare Imbrium. Beginning at the northern point, we first come to the very remarkable bay known as the Sinus Iridum. Then comes Plato, and then the gulf sweeps round by a noble range of mountains called the Caucasus, between which and the range of the Apennines there is a passage which leads into the Mare Serenitatis.

At this point the observer will not fail to notice three splendid rings lying out in the Mare Imbrium. The smallest of these is the Autolycus. Directly below that is the larger ring known as Aristillus, which is thirty-four miles in diameter. Its rampart rises upward of two miles above the surrounding plain, while the interior of it is depressed some 3,000 feet below the level of the general lunar surface. Aristillus may be regarded as a typical lunar crater, inasmuch as it is adorned by a lofty mountain peak ascending from the center. A view of the multitudes of details in this mighty extinct volcano will reward the diligent student who has the use of a good telescope. If he should be an artist, he will find ample scope for practice with his pencil in delineating the many features of this superb piece of lunar scenery. The third of the three craters which form this noteworthy group lies far out in the Mare Imbrium, and is the famous lunar object known as Archimedes. This crater is not quite so large as Plato, but its floor presents multitudes of points of interest to assiduous lunar observers.

Returning, however, to the neighboring coasts from our survey of these objects out in the Mare Imbrium, we perceived the splendid range of the lunar Apennines. The objects so called are by far the most magnificent range of mountains that can be seen on the moon, ascending, as some of its peaks do, to an altitude of about 18,000 feet above the surrounding plain. This superb range extends for a distance of no less than 400 miles along the shore of the Mare Imbrium, and the special summits which have been noticed upon it are to be numbered in hundreds. The Apennines project a mighty promontory into the Mare Imbrium, which terminates in the crater known as Eratosthenes. This object is of interest as being, perhaps, the volcanic vent for the mighty forces which were once concerned in the upheaval of this mountain range connected with it.

The promontory thus magnificently ended points to another lunar feature. This is the great crater Copernicus, which is regarded, and I believe justly regarded, as the most noteworthy object on the moon. It stands isolated in the Oceanus Procellarum, and this peculiar situation gives to Copernicus a distinctness which makes it very easy to recognize. The central regions of the ring are adorned by a mountain, some of whose peaks attain about half a mile in altitude. Among the features which make Copernicus specially interesting as a telescopic object are the remarkable terraces which are to be seen in its interior. They are apparently due to successive floodings of the crater by lava. It seems probable that they were produced in the following manner: Suppose that in connection with some outbreak the crater became filled with lava, then after a period of quiescence the surface of this would become congealed. If the molten lava beneath subsided, it would leave a margin of solidified material, which would form the first or highest terrace. At a subsequent outbreak the basin might have been only partially filled, so that the lava did not ascend to so great an altitude. This would in due course become congealed on the surface, and again the lava would subside, thus forming a second terrace.

I must here specially mention a remarkable characteristic of lunar scenery which is displayed on a grand scale by Copernicus. I allude to the presence of bright radiating streaks which extend from the great crater for many hundreds of miles over the lunar surface. The explanation of these bright streaks offers one of the most difficult problems in lunar physics. They are sometimes thought to mark lava flows from the central spot at some earlier phase of eruption than the crater as it now stands would indicate. It does not, however, seem apparent why these streaks should in this case possess the peculiar brightness which characterizes them.

Near the southern pole of the moon is the remarkable crater known as Tycho. This is situated in a region where the scenery indicates the wildest and most magnificent confusion. Tycho is specially noticeable for the number of bright streaks which radiate from it. Indeed, at the time of full moon, when these streaks are peculiarly visible, they have frequently been likened to meridians diverging from a pole. Nasmyth supposed that these streaks were due to cracks in the moon, and that through these cracks lava had welled out from beneath. He gives a striking illustration of the mechanical possibility of this doctrine, by showing how a glass globe has been observed to crack in such a way as to produce a system of streaks exactly resembling those seen to diverge from Tycho on the moon.

It is known that great volcanic outbreaks on the earth, such, for example, as the renowned discharge which took place at Krakatoa in 1883, have been attended with the evolution of enormous quantities of volcanic dust, or comminuted pumice, which was of a light grayish color. It may, as Mr. Elger suggests, perhaps have happened that volumes of volcanic dust have issued from the fissures produced in the moon, under the influence of the cracking suggested by Nasmyth. This dust would accumulate along the lines of fissure; for it must be remembered that, as there is no air on the moon, there would be no wind to blow the dust away, as there would be on the earth. There, consequently, the dust would remain, and its characteristic whiteness would present just the same appearance that the streaks now seem to have. This view seems to present the most reasonable explanation at present available as to the origin of these remarkable lunar characteristics.

One more striking feature in the scenery of our satellite should be referred to. I mean the deep but narrow clefts or chasms which extend for hundreds and often for thousands of miles across the lunar surface. These chasms seem in all probability to owe their origin to earthquake shocks, by which the moon was shaken in the days when its volcanoes were still active. Those days seem, however, to have long since passed. The volcanoes on the moon no longer give any manifestation of energy. They are all extinct and silent; for though one or two cases have been recorded in which apparent changes have been thought to have taken place, yet, even if we admit the reality of such changes, they are but insignificant.

The fact is that the moon appears to have lost its volcanic energy. This is doubtless due to the circumstance that our satellite, being a small globe, relatively to the earth, has already cooled down to such a point that there is no longer sufficient internal energy left to produce a volcanic outbreak. The earth is so much larger that it still retains large quantities of internal heat, which manifests itself occasionally in the eruption of volcanoes. The difference between the earth and the moon in this respect may be expressed in this way: That while we have many extinct volcanoes on the earth, and comparatively few active ones, yet on our neighboring globe all the volcanoes seem to have passed into the extinct condition.

METEOROLOGY IN SCHOOLS.

AMONG the many new subjects that are now pressing for admission to the course of instruction in our schools there is none better entitled to such admission than meteorology. There is no subject of greater practical importance. There is none a knowledge of which does more to make our daily life interesting. There are few subjects that lend themselves more readily to teaching. The next few years are destined to witness a very great extension the teaching of meteorology in our schools. At present this teaching, so far as there is any, is vague, indefinite and unsystematic in many cases, because the teachers themselves do not know how to go to work.

The liberal policy of our weather bureau makes it possible for every school in the United States to receive a daily weather map, an opportunity given to the schools of no other country. These maps present the facts of the weather conditions over the United States, and it is from these facts that the scholars should be taught to draw their own conclusions as to the general laws controlling our weather and its changes from season to season and from day to day.

Simple observations, however carefully made, are not enough. A simple inspection of the daily weather map, with its great store of material gathered from all over the country, is not enough. The observations should be summarized and studied, and the results of such study should become familiar to all the scholars. Then a systematic progressive course of instruction in the practical use of the weather map should follow. Beginning with the simple elements alone, such as temperature, winds and weather, and going on to the more complex relations existing between pressure and weather, etc., the children will progress materially and without difficulty, until they have discovered for themselves the principal laws which are working to give us our changes from hot to cold and wet to dry.

Such systematic study of the daily weather maps is easily within the scope of the children in the upper and middle grades of our grammar schools, and it should unquestionably precede any text book work, which may be taken up later, if opportunity offers. In order to advance and systematize the teaching of meteorology in our schools, the New England Meteorological Society two years ago offered a brief course of instruction in the use of the daily weather maps, in accordance with the recommendations of the committee of ten on secondary school studies, to teachers in places in the vicinty of Boston. This course has now been given in Cambridge, Hingham, Natick, Abington, Brockton and Peabody. In all these places instruction in meteorology has been introduced into the schools, in accordance with the scheme proposed, and the results attained have been satisfactory. The experiment has proved everything that was expected of it.

The work thus begun in a small way here in New England, where so much has been and is being done for

meteorology, is an indication of what will be carried out all over the country before many years. Certainly the United States, which has given to the world Franklin, Espy, Redfield, Maury, Loomis and Ferrel, should see to it that all its school children are taught something of the science which those men did so much to build up.—Connecticut School Journal.

THE ORCHID DISA PULCHRA, SONDER.

THE flowering of this remarkable and showy species, for the first time under cultivation in the collection of orchids belonging to the Hon. Walter Rothschild, Tring Park, is a very noteworthy occurrence. Although the species was originally described in Linnæa, XIX, 1847, and dried specimens gathered on the eastern frontier of the Orange Free State had often excited admiration, no one had succeeded in inducing any of the few tubers imported to produce flowers to verify the beauty which the dried specimens showed that the plant must have had when living. Some spikes are two feet in height, bearing upward of twenty flowers, all of which are open at the same time.

Disa pulchra has stout tubers, and the plant progresses by making new tubers to take the place of the old ones, which gradually decay after flowering. It does not produce young plants on stolons like D. uniflora, D. tripetaloides, D. racemosa, and others of that section. An extraordinary point about it is that when

DISA PULCHRA.

S, sepals; S P, spur; P P, petals crossing at the tips; L, lip; S T, stamen, with P O, pollen masses; O, ovary.

observed at a short distance, the leaves and inflorescence bear a stronger resemblance to some species of Gladiolus than to any of the other Disas. Its leaves proceed from the crown of the tuber, are firm in texture, of a bright green color, and on the inflorescence gradually diminish into the bracts, which equal in length the red-purple ovaries. The leaves, as they ascend, get rather lighter in color, the bracts themselves being pale lilac tipped with green. The segments of the flowers are more equal, and arranged like those of some of the epiphytal orchids than those of any other species of Disa. The odd sepal, which is slightly concave, is the largest of the three, and it is prolonged into a spur one inch in length, which, in the older flowers, turns abruptly upward. The sepals are of a pale lilac tint, with a few slight purple lines and dots, and the spur is colored light purple. The petals are much smaller than the sepals, and curiously crossed over the short column at the base, closely folding over the pollinia, and the blade of each crossing to the opposite side; in color lavender, with a distinct purple margin. The lanceolate lip is nearly as large as one of the sepals, and in color of a light shade of lilac, with a very thin purple margin and line running down the center. The color of the flowers is said to vary from white to purple. It is a most desirable species, which it is hoped will be as amenable to culture as are some other showy Disas introduced of late years. At Tring Park, the tubers were potted into fibry peat, loam, and sand, and placed in a cold frame for the summer, and on two or three showing flower-spikes they were placed in an intermediate house, where the one forming the subject of our illustration successfully developed its flowers.

A NOVEL EXPERIMENT ON VEGETATION.

THE eminent French astronomer Flammarion has lately communicated the following interesting report to a French journal, says the Gardeners' Chronicle:

We have undertaken at Juvisy the study of the various rays of the solar spectrum. A Violles registering actinometer with conjugated thermometers, a vapor actinometer, a Crookes radiometer, a registerer of the hours of sunshine, and several series of colored thermometers are in constant use, and render it possible to calculate the caloric received according to the season, the hour of the day, the state of the atmosphere, etc. The object of these observations is to ascertain if there is not some relation in our atmosphere in the complex question of climate, between the caloric received from the sun and the state of that luminary.

In the course of these studies we thought it interesting to investigate the peculiar action of the sun on vegetation, which is a transformation of the solar energy. Which are the rays of the spectrum which act most efficaciously? It is possible to distinguish the luminous rays from the caloric rays and the chemical rays, to seek the characteristics which distinguish the slow radiation of the red end of the spectrum from the rapid radiations of the violet end, and to ascertain which are those that exercise the most favorable influence upon certain phenomena of vegetable life. With this object, we constructed glass frames with glasses which had been carefully examined with the spectroscope. It seemed impossible to find perfect violet rays, though twenty-two specimens were examined, for all allowed the passage of the yellow or green rays. We were, however, able to obtain blue glasses very near to violet, which only allowed the passage of the rays from the right extremity of the spectrum. The red glasses are almost monochromatic, and only allow a little orange to pass. The green are less satisfactory.

We thus constructed, side by side in the same meteorological conditions, three frames, red, green and blue, to which we added a transparent white glass, to enable us to compare the effects of full sunlight. In order to render the conditions as natural as possible, and avoid too high a temperature, the frames are ventilated by a current of air passing from south to north, but the light from outside cannot enter the colored frames, even by reflection.

Among the many results which we obtained, it is interesting to mention the observations which were made on sensitive plants, which were chosen as subjects of experiment on account of their extraordinary sensitiveness.

The sensitive plants, all sowed on the same day (May 25, 1895), in the same soil, measured about 22 millimeters on July 4. We then made a selection of equally developed plants, which were potted in perfectly similar earth, and left under a frame to recover from that operation. On August 1, the pots, each containing two sensitive plants, 27 millimeters in height, were placed in the colored frames. By August 15 differences in growth, coloration and sensitiveness were apparent, and became more and more marked. We registered the development of the impartial plate of a photographic apparatus, and the following are the results obtained:

Dates.	Red.	Green.	White.	Blue.
	Meters.	Meters.	Meters.	Meters.
September 6	0·220	0·090	0·045	0·027
" 27.....	0·345	0·150	0·080	0·027
October 22	0·420	0·150	0·100	0·027

Thus the sensitive plants in the red frame attained an ordinary development and reached a height fifteen times superior to that of those in the blue frame, which remained absolutely stationary. The red light produced the effect of chemical manure (though there is no question here of actinic rays). The plants were all cared for in exactly the same way—that is to say, simply watered.

The sensitiveness of the red plant reached such a degree that the slightest movement, a mere breath, sufficed to make its leaves close and all its branches droop at once. Moreover, the red plant flowered on September 24.

The white, instead of growing in height, gained in strength, and became extremely vigorous. It showed buds. The foliage of the sensitive plant grown under red glass is lighter than that of the white, which is paler than the green; the blue is darker.

The difference between the temperature of the frames was not great, but the white was warmest. Next came the red, the green, and the blue. The luminous intensity decreased in the same order in much greater proportions.

Such is a summary account of the facts observed. Scientific experimenters, notably MM. Pfeffer, Prillieux, Sachs, Guillemin, De Famitzin, Draper and Paul Bert, long studied the action of various rays on vegetation. Paul Bert's results approach the more nearly to ours, though his experiments were not made in the country, but in the hothouse of the Faculty of Medicine, and between October and January, in a comparatively weak light. His result showed developments in the following order: white, red, blue, green.

We found, for growth in height, the following sequence: red, green, white, blue; and for vigor and activity of vegetation, red, white, green, blue. The blue frame does not allow the passage of any red rays, but plants do not die in it.

We have observed similar phenomena, though less pronounced, with geraniums, strawberry plants, pansies, etc. The strawberry plants in the blue frame were not more advanced in October than they were in May.

In explanation of these phenomena, we would remark that, according to the experiments of MM. Deherain, Vesque, Engelmann, Wiesner, etc., the red and orange rays increase the respiration of the leaves and the assimilation of carbon, and favor transpiration, whence there must result an increase of circulation and nutrition.

These experiments were made at the station of Climatologic Agricole at Juvisy, with the assistance of M. Georges Mathieu, ingénieur agronome.

SWEDEN'S GREAT EXHIBITION.

ACTIVE preparations are being made by the commissioners who were appointed for that purpose to make the great industrial exhibition which will take place in Stockholm next summer complete and instructive, says the New York Tribune. The exhibition will be known officially as the Scandinavian Art and Industrial Exhibition, and it will be held in celebration of King Oscar II's twenty-five years' reign. Every branch of industry and learning will be represented in the exhibition, the products of the workshop and of the ground will be placed on view, and collections will be shown by which the visitor may see what progress has been made since the present sovereign took the reins of government. Although the exhibition will be Scandinavian, the co-operation of Russia has been obtained, and that country will be represented in all departments of the exhibition.

The official programme says: "The compatriots of Nordenskiold, Nansen and Andrée have invited the entire North, and Russia has signified her intention of an official participation." The Russian exhibit will probably be one of the chief attractions of the great fair.

In speaking of the undertaking the Norwegian consul at New York said: "The exhibition will be, in all respects, like the great world's fairs, but, inasmuch as only Scandinavian countries and Russia will take part, it will not be so vast and extensive as those expositions have been. But beautiful buildings are being erected on an island which is a part of the city of Stockholm, in which the farm products, the minerals, the woods and everything else which is found and raised in the North will be exhibited. Halls are also being erected for the exhibition of our machinery and manufactured products, and places of amusement will be provided for the thousands of visitors who will be attracted to Stockholm after the exhibition has been opened."

The official circular says: "The Scandinavian kingdoms—Sweden, Norway and Denmark—have never before prepared with such energy for any exhibition as

for this. Everywhere in these countries, so rich in iron, boundless forests and thundering waterfalls, from the North Cape to the German frontier in Denmark, from the deep Norwegian fiords to the Baltic, unremitting toil is carried on for the exhibition. The Scandinavian exhibition of 1897 will, in fact, be the grand rehearsal for the entire North of the international Paris exposition of 1900.

"The art exhibition will not be confined to the North countries, as the commissioners have invited the co-operation of France, England and Germany, and it is expected that many works of art from those countries will be exhibited.

"There will be many novelties among the attractions, and in lieu of a Ferris wheel or Eiffel tower there will be a mammoth cave."

A STRANGE ISLAND.

SAGHALIEN, on the eastern coast of Siberia, presents a very curious anomaly of climate, says Cosmos. "The island is bathed by two cold ocean currents, and in winter nothing protects it against the icy northwest winds coming from Siberia. At the sea level the snow falls continually, and stays on the ground till the end of May, and the seashore is very cold. Farther inland, however, especially as we go higher up, the climate is modified—just the opposite to what is observed elsewhere. It has often been observed in Siberia and in Central Europe that in winter the cold is greater in the plains and the valleys, and that the highlands have a sensibly milder temperature; it is as if the denser cold air accumulated in the lowlands. This fact is very often observed in our climate: there are several very good examples of it: all the trees and shrubs of a valley have been known to be killed by frost, while above a certain level, very clearly marked out, on the hill or the mountain, the vegetation has not suffered at all. The cold air often flows from the summits toward their bases. This is what takes place at Saghalien. The cold air accumulates in the low regions of the island and on the coast; the higher regions have a more elevated temperature. So it happens that the lower parts have an arctic vegetation, while the intermediate altitudes have the vegetation of a temperate zone, sometimes subtropical. . . . The birch, the ash, the pine, the fir, abound in the low regions and form often impenetrable forests, but toward the center of the island appear bamboos, hydrangeas, aralias, and other plants that one is greatly surprised to meet, and whose presence can be explained only by the altogether abnormal climatic conditions of the island."

PASTEUR'S TOMB.

THE tomb of Pasteur, which is now in course of construction under the direction of M. Charles Girault, may be said to have some affinity, although it will be on a much smaller scale, with the great tomb of Napoleon in the Invalides, says the Churchman. It forms a part of the Institut Pasteur, in the Rue Dutot, for the crypt which is to contain the sarcophagus has been excavated to a depth of about sixteen meters, or fifty-three feet, below the vestibule. The approach will be down a vaulted staircase. Above the entrance to it is a cartouche containing as an inscription a thought of Pasteur's, to the effect that "He is happy who carries in his mind and obeys a God, an Ideal of Beauty, an Ideal of Art, an Ideal of Science, an Ideal of Patriotism, an Ideal of the Evangelic Virtues." The central part of the floor of the crypt is raised to form a dais in mosaic for the sarcophagus, which will be of Swedish porphyry. Over it is a cupola, supported by twelve porphyry columns with Ionic capitals. Facing the staircase is a small chapel or apse. The cupola is covered with mosaic. In the center are four winged figures, designed by M. Luc Olivier Merson, symbolizing "Faith," "Hope," "Charity" and "Science." Around are figures of the vine, hop and mulberry, which suggest Pasteur's discoveries in fermentation, and figures of animals that were the subjects of his later investigations. The walls are veneered with marbles, while the steps, as well as the bases and capitals of the columns, are in white marble. The whole structure is worthy of the man it commemorates, and in his Institut it has a significance which it could not possess if it were erected in one of the Parisian cemeteries.

PREDICTION OF EARTHQUAKES BY ANIMALS

"M. CANCANI has collected," says the Revue Scientifique, "a considerable number of instances where animals have plainly given signs of disquietude or fear before shocks of earthquake. It is not necessary to suppose any peculiar mode of foresight in these animals; they are in all probability influenced by the very slight tremors that precede the heavier shocks. In all cases, as M. Cancani remarks, this disquietude of the animals is observed only in cases where the center of disturbance is at a considerable distance, and he supposes that the shorter vibrations travel a very little quicker than the longer ones, and that at a considerable distance the difference becomes appreciable, so that the light tremors arrive sufficiently long before the shock to affect animals before the latter occurs."

GULF OF ST. LAWRENCE TIDES.

THE Railway Engineering News says: "The tidal survey of the Gulf of St. Lawrence has been in progress for three years. The first season was occupied in examining the Belle Isle and Cabot Strait entrances and in fixing the general relation between the tides and currents of the gulf and the ocean. The second season was devoted to the St. Lawrence entrance between the Gaspe coast and Anticosti, and the nature of the currents was traced across the southwestern side of the gulf to Cape Breton. During the present year the northeastern arm of the gulf from Anticosti to Belle Isle has been under examination. This arm of the gulf has an area equal to that of the English Channel, and through it passes all the Atlantic trade taking the Belle Isle route. Tide tables are now published covering the approach from Halifax to Quebec, the first tables which are based upon direct observations."

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